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Children and Youth in Organized Sports

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CHILDREN AND YOUTH IN ORGANIZED SPORTS

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CONTENTS

PREFACE

Participation in sports at the community level is a major feature of daily living for children and adolescents in many countries of the world. Structures of organized programs vary considerably, and sport offerings vary with cultural context.

Sport is also important in the primary business of children and adolescents, i.e., the business of growing, maturing and developing. Sport is a primary source of physical activity for many children and adolescents, and is an arena in which personal and inter-personal values and behaviors are developed and nurtured. And, key players in these important functions of sport are coaches and parents.

The present volume provides in depth discussions of youth sport from these two perspectives, i.e., youth sport in different cultures and as an important dimension of the daily lives of growing, maturing and developing children and adolescents. The first part highlights youth sport in the Portuguese cultural context. The second part focuses on youth sport as a part of development, i.e., the learning of culturally appropriate behaviors, motivations, and so on. It considers youth sport participants, coaches and parents, and includes data from Portugal, Mexico, the Netherlands, the United Kingdom and the United States. The third section considers youth sport in the contexts of growth and maturation, biological processes that are central to discussions of training. In addition to several general discussions, two internationally popular youth sports are highlighted, soccer and swimming. The final section considers the risk of injury in youth sport in general, in the context of psychological factors, and then in the context of artistic gymnastics.

This volume is primarily for students of physical education and Sport Science, coaches, trainers and others involved in youth sport programs and IN the preparation of young athletes. The contents have application to in a variety of cultural contexts given the near universality of sport for youth throughout the world. Focus is on the youth sport participant or the young athlete as a child/adolescent with the needs of a child/adolescent. The demands of sport are superimposed on the biological and cultural demands of childhood and adolescence. All too often this is overlooked, especially at the more elite youth sport levels. The editors hope that the contributions which comprise this volume will serve to enhance the sport experiences of youth, minimize potential risks, and maximize potential benefits.

Manuel Coelho e Silva
Robert M. Malina
Editors

FOREWORD

For decades, family and school were conceived as the main agencies for the involvement of children in sport. Social changes in most European countries and the universal recognition of sport as a relevant activity in everyday life compelled to the intervention of many other agents, aiming to expand sports for children and youth as a more systematic, safer and rewarding educational and cultural experiences. While the pressure from competitive sport oriented the search for the talented youngsters and the improvement of training methods, sport for all also received the attention of governing and educational authorities owing to its benefits for children's basic needs, as for example, motor development, health, recreation and acquisition of active life style.

Great progress was registered in the quality of life of the young generations until new threats came recently into light. There is everywhere an increasing offer of new forms of play and time occupation whose indisputable result is a dramatic decrease of children's physical activity. Figures were recently published in several European countries regarding the number of hours per week children and youth spent at home playing computer games of different kinds and watching television. Portuguese adolescents were reported to be the most addicted to TV watching in the European Union. Medical statistics show a steady increase of overweight rates among both adolescent boys and girls. It is not surprising that more and more people currently fear that the trend may intersect the United States levels for obesity in the near future.

Apparently, the highly sophisticated and demanding training methods at relatively young ages may also contribute to a serious decrease of participation in sport by youth. School life appears to be hardly compatible with schedules imposed by specialized training programmes and competitions. The ubiquitous trend to move backwards the age at which boys and girls start a career in competitive sport adds an extra difficulty to retain active young athletes in many sport clubs and federations. Without strong encouragement from governmental bodies and cooperation with sport agencies, the conflict between school and sport may reach undesirable levels in many countries.

Further, other constraints to youth sport are beyond the control of men and institutions. Demographic changes reflected in reduced birth rates and increased population mobility (leading to the rise of mega-cities and associated desertion of vast areas of inner lands), make it difficult to attract and keep children active in sport in a regular basis.

New cultural and social conditions call for new policies and targets of research. Much of the literature published in the 1980s and 1990s on children and youth in sport provides a strong basis for the pursuit of solutions demanding the contribution of various fields and methods. I am very happy to see some of them clearly delineated in the following chapters, and grateful to the Editors for the quality and timeliness of this book.

Francisco Sobral
University of Coimbra

FOREWORD

The topic of youth sport is not new yet we have much to learn. It is pleasing, therefore, to see this comprehensive and multidisciplinary text come to fruition. It is particularly important to consider young people's development, growth and maturation through their years of involvement in sport, but to place these issues alongside the philosophical, social and psychological issues of the players, coaches and parents.

Is sport good for young people? Reactions range from the uninformed positive or negative to evidence-based statements. We need more of the latter. Does sport build 'character'? Let's look at the evidence rather than 'second guess' through personal anecdote or experience. Do those participating in school sport do better academically because of their sport involvement? Let's systematically evaluate the evidence. To this end I am delighted to see that Manuel and Robert have brought together a wealth of diverse expertise from many different countries to evaluate key questions and issues in youth sports. Varied topics are addressed – programme quality, values, growth, learning – in different sports and with different populations.

I believe that this text will 'make a difference' in this most important of areas.

Stuart Biddle
Professor of Exercise & Sport Psychology
Head, School of Sport & Exercise Sciences
Loughborough University, UK

FOREWORD

The University of Coimbra, founded in 1290, is one of the oldest in Europe. As Rector, I am honoured to introduce the first title from our youngest faculty.

After completing 10 years, the Faculty of Sport Science and Physical Education is demonstrating that its group of young, motivated researchers is maturing in the context of contemporary trends in their respective scientific areas.

The content of the manuscripts and their scientific and professional merit has been evaluated by recognised experts who strongly recommended publication. Although not being in a position to fully appreciate the scientific scope and potential impact of the volume, it is important to emphasize that it represents a unique approach in Sport Science to a topic of increasing interest throughout the world – children and adolescents in sport at all levels from community to international. This is an area of research focus into the future both for undergraduate and graduate students at Coimbra and other universities worldwide.

Current academic conditions demand new srategies to produce research based on international collaboration and networks. It is, indeed, a pleasure to recognize the efforts of 36 contributors who represent 19 universities from 10 different countries spanning four continents.

The enthusiasm of the editors must also be highlighted.

Fernando Seabra Santos
Rector, University of Coimbra

Part 1:

ISSUES IN YOUTH SPORTS

CONTEMPORARY TRENDS AND ISSUES IN YOUTH SPORTS IN PORTUGAL

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Over the past decades, several books and symposia have targeted the topic of the child in sport. One of the first was "Children and Sport: A Contemporary Anthology" (Magill *et al.,* 1978), which went into two additional editions (Magill *et al.,* 1982; Smoll *et al.,* 1988). At the Olympic Scientific Congress in Eugene (Oregon) in 1984, one of the themes was "Competitive Sport for Children and Youth" (Weiss and Gould, 1986). Increasing interest in youth sports is also evident in subsequent volumes, including: "Advances in Pediatric Sport Sciences" (Boileau, 1984; Gould and Weiss, 1987); "Competitive Sports for Children and Youth" (Brown and Branta, 1988); "Young Athletes: Biological, Psychological and Educational Perspectives (Malina, 1988); "Sports and Children" (Chan and Micheli, 1998); "Children and Youth in Sport" (Smoll and Smith, 2002) and "Youth Sports: Perspectives for a New Century" (Malina and Clark, 2003). In Portugal, Sobral (1988a) introduced the topic of youth sports in a volume entitled "The Adolescent Athlete."

The purpose of the present paper is to highlight trends in youth sports in Portugal in the context of demographic and political changes over the past 25 to 30 years. In doing so, the paper draws on corresponding data from other countries to provide a comparative perspective.

1. DEMOGRAPHIC TRENDS

Sport is a central phenomenon in many societies. This trend has been labeled the "sportification of society" (De Knop *et al.,* 1996a) and includes both participants and spectators. On an annual basis, about 23 million people visit sport parks to see professional games in Japan (Yamaguchi, 1996). Within the last decades German adolescents have doubled the time invested in informal and organized sport, in part, due to expanding education. (Brettschneider and Sack, 1996).

An important factor affecting sport participation is change in population composition. It is estimated that Europe will have 16.8 million fewer children and youth (0-19 years) in the year 2020 compared to 1990 (Eurostat, 1992). From the perspective of an individual country, for example, a decrease of 250,000 children and youth <20 years of age in Belgium has been projected between 2000 and 2050 (De Knop *et al.*, 1996b). This is a large decrease which has major implications in a country of about 10 million inhabitants.

Portugal is a country that is similar population size to Belgium. The total population of Portugal increased 15.4% between 1970 and 1991 (Barreto, 1997), but the distribution of the population has changed. The coastal area has attracted many investments and communications have improved to allow better access to Lisbon and Oporto. Municipalities located between these major urban areas show fairly reasonable demographic stability, due in part to the service and trade sectors. In contrast, inland areas have lost population. The trend began in the 1960s and 1970s when there was large scale emigration, primarily males, which was accompanied by a decline in birth rate. This had immediate implications for education. Education beyond compulsory attendance in some municipalities was no longer viable or was not been considered a priority issue by local authorities. Further, many schools have closed.

Under such conditions, those who remain in rural areas often do not have an opportunity to further their education. Individuals with interest in furthering their education are forced to move and often do not return. This situation compromises social developments, including sport among others. The promotion of sport participation is more difficult in rural communities since the youth population is not very large and is rather dispersed. Transportation within relatively vast areas is thus essential to create a club or even a team. Other developmental factors such as sport facilities and staff are also limited in rural areas. Although national data to this effect are not available, data for the District of Coimbra indicate a reduction in sport facilities and staff in rural areas (Coelho e Silva, 2001).

3. PATTERNS OF YOUTH SPORT PARTICIPATION

PARTICIPATION IN ORGANIZED SPORT

Data for several countries indicate generally similar trends in youth sport participation. Note, however, that criteria for definition of sport participation are not universal and studies vary in sources of information and quality of data, e.g., official data versus specific surveys, self-report by youth and/or their parents, and so on.

It is estimated that 20 to 35 million children and youth 5-18 years participated in non-school sports in the United States in the early 1990s (Ewing and Seefeldt, 1996). Although, these numbers probably represent an overestimation due to participation in more than one sport by many youth, they show the general interest of American youth in sport. The *Campbell Survey of the Well-Being* similarly demonstrated reasonably widespread participation in sport among Canadian youth. About 42% of males and 37% of females 10-14 years, and 44% of males and 28% of females 15-19 years participated in competitive sports at least weekly (Stephens and Craig, 1990). About 47% of Welsh youth 11-16 years belonged to youth organizations (Sports Council for Wales, 1993), and as many as 54% of 12 year old Finnish boys participated once a week in training sessions and competitions organized by sport clubs (Laakso *et al.*, 1996).

Participation in organized sports peaks during adolescence and subsequently declines. Among Scottish yough, sport participation declines after a peak at 14-15 years of age, while attending entertainments such as discos, pubs and cinemas increases until 19-20 years (Hendry *et al.*, 1993). The total number of Australian boys and girls that participates in sports peaks at 15-16 years of age (Blanksby *et al*, 1996). The percentage of adolescents engaged in organized sports increases from 38% (boys) and 40% (girls) at 12.5 years of age to 41% (boys) and 50% (girls) at 16.5 years of age. Corresponding estimates for participation in recreational activities are 80% (boys), 54% (girls) at 12.5 years of age, and 77% (boys), 57% (girls) at 16.5 years of age in Australian youth. Finally, from ages 12.5 to 16.5 years, health and fitness activities increase from 8% to 15% in boys and 21% to 44% in girls.

According to Direcção-Geral dos Desportos (1988), about 130,000 Portuguese youth participated in competitive sport club activities in the mid-1980s. This represented approximately 6% of the Portuguese population 6-18 years. In a more recent study (Marivoet, 2001), the highest rate of sport participation between 15 and 74 years of age occurred in Lisbon (27%), followed by the North of Portugal (26%), while the Midlands had the lowest rate (14%). These estimates suggest that participation in sport activities is more common in urban settings.

POPULARITY OF SPORTS

Participation of Canadian youth 15-20 years by activity were: swimming (58%), baseball (44%) and ice hockey (40%) for males, and swimming (69%), skating (34%) and baseball (30%) for females (Stephens and Craig, 1990). In the United States, participation in school sports among youth 10-18 years in order of popularity was as follows: football (16%), track and field (16%), basketball (16%) and baseball (15%) among males, and track and field (12%), basketball (12%), softball (11%) and volleyball (10%) among females (Seefeldt *et al.*, 1992). Participation trends for high school sports in 1999-2000 in the United States are essentially the same (National Federation of State High School Associations, 2001).

The most popular sports among 5-15 year old New Zealand youth were: rugby (53%), swimming (40%), tennis (40%), cycling (38%), snooker/pool (39%) for boys, and cycling (46%), swimming (40%), tennis (39%), aerobics (39%), netball (26%) for girls (Russell *et al.*, 1996). In an earlier survey of New Zealand youth 15 years of age, the picture of sport preferences was essentially the same with the exception of cricket which appeared as the third most popular sport among boys, after rugby and swimming (Reeder *et al.*, 1991).

Popularity of sports among Flemish Belgian youth ranked swimming first among boys and girls, followed by soccer in boys and gymnastics in girls (De Knop *et al.*, 1996b). In Finland, soccer and ice hockey were the most popular sports for boys, and gymnastics, track and field and volleyball were more popular among girls (Laakso *et al.*, 1996). Telama (1988) detected Other popular activities among 14 year old Finns were jogging/running, cross-country skiing and biking (Telama, 1988).

Official estimates for popularity of competitive sport participation in Portugal in the mid-1980s, in order of popularity, were as follows: soccer, track and field, handball and basketball for boys, and track and field, gymnastics, handball and basketball for girls (Direcção-Geral dos Desportos, 1988). Data for youth 15-18 years actively participating in organized sport in the Portuguese Midlands in the late 1990s indicated that about 67% of males were engaged in team sports, whereas about 57% of females were engaged in individual sports (Coelho e Silva, 2001). The most popular sport for boys was soccer, followed by swimming and basketball; the three most popular sports for girls were swimming, soccer and basketball.

4. YOUTH SPORT PROGRAMS IN PORTUGAL OVER THE PAST DECADES

YOUTH SPORTS PRIOR TO 1974

Political and demographic changes in Portugal have influenced organizations, institutions and programs related to sport and also perceptions and concepts about the role of physical education and sport in society. This heritage can be briefly summarized as follows:

- Government control of sport organization at all levels from national federations to regional and city organizations and clubs is the rule.
- Funds for facilities and activities come almost exclusively from public sources – central or local.
- The concept of sport as a non-priority activity with a non-relevant contribution for material or social progress has resulted in a very small investment in sport for more than 40 years.

- The low level of education of sport managers is due to the country´s global situation and to the local character of the clubs (Teixeira de Sousa, 1988).
- The lack of scholarship and specific training of coaches is due to the limited number of faculties of Physical Education and Sport and of training programs for coaches in the sport federations.
- A reduced number of participants in sports and physical activities offered in schools and clubs is evident so that initiation of sport generally occurs rather late (adolescence), with the exception of soccer and exclusive swimming clubs with competitive programs (Gerardo and Gomes Ferreira, 2002).
- As a result, the quality of performances and results were generally low for Portuguese athletes in major international competitions.

ORGANIZATION AND PHILOSOPHY OF ORGANIZED YOUTH SPORT AFTER 1974

The Organization

The new government retained control of sport in a department of the Ministry of Education that integrated Competitive Sport, School Sport and School Physical Education (Direcção Geral de Educação Física e Desportos, later Direcção Geral dos Desportos - DGD). This situation changed in 1976, when Physical Education and School Sport became a new department comprising the basic and secondary school branches, beginning separate paths for club and school sport (rarely convergent, often in conflict) that has remained to the present. The dependence of sport on the Ministry of Education lasted till 1995, when the Ministry of Youth and Sport was created.

The Philosophy

The evolution of competitive youth sport in Portugal can be divided into three phases. Although is possible to observe a general pattern of changes during the last three decades (1974+), all federations did not move in the same directions, at the same time, and with the same speed. The major federations are those responsible for almost all youth sport activities in the country: soccer, basketball, handball, volleyball, hockey, track and field, swimming and judo.

1974-1985: Partnership between State and Sport Federations

After 1974 the public administration for sport declared its intention to build "a new sport for a new country" (Melo de Carvalho, 1975). The main concept was that sport is a factor of progress and socialization with significant impact on the quality of life for the people. Therefore, sport must be accessible to the total population with no limitations, including those who want to participate regardless of level of competence.

The Constitution of 1976 established that all citizens have the "right to sport" and so the State has the obligation to promote and support sport either for recreation or high-level performance. The main idea was to increase the number of participants in sport activities on a mass basis, especially among youth. During this period a program was created mainly to develop youth sports. To enforce this political choice, the government used several strategic options:

- The State must promote, support and "make" the activities in partnership with sport federations, clubs and organized citizens.
- Funds for national federations were substantially increased, looking for rapid improvement of competitive sport quality.
- To consistently raise the quality of activity, it is vital to have an educated and trained staff – physical education teachers, coaches and club managers. Faculties of Physical Education were submitted to major changes, and Direcção Geral dos Desportos and federations started important programs of coaches education and training, setting the basis for a coaching career.

Both the State and federations looked to attract youth to sport stimulating a "boom" in sport participation among youth. The increased participation was specifically achieved through competitions for pre-adolescents and adolescents. As a result, the age of beginning for sport activities became much lower than before. The greatest increase in competitive youth sport participants – shown by the numbers of sport federations – was reached in the age group of 10-12 years.

For sport federations, the mass provision of youth sport opportunities meant more funds from the government and a growing quality of high-level athletes. The concept was classic: from quantity appears quality. Until the mid-1980s, federations multiplied the competitions for young people at local, district and national levels. At the same time, sport federations started to look with more attention to elite young athletes. With the new position of the country in the international domain, both State and federations saw international youth competitions as a way to prepare future Olympic champions and to gain prestige and advantages. Young national teams started to prepare and compete regularly in European championships and other international tournaments for specific age groups.

1985-1995: Rise of elitism

The partnership between the State and federations gradually started to move in favor of the federations. In 1985, the new government decided to abandon all organization of sport activities, but assumed a role related to funding, coordination (interface) and control. In this new position as the main actor in the sport system, federations began to define new areas of intervention in youth sport programs. From 1986 through the mid-1990s, all major federations started to look with a growing attention to their young elite athletes. Successes in international youth competitions, in turn, were viewed as a strategic option.

Poor results in international competitions in the previous years were seen as a consequence of several factors:

- Insufficient attention to elite young athletes,
- Lack of talent detection, selection and development programs,
- A small number of young athletes in elite programs,
- Lack of investment in training and international competitions for junior national teams, and
- Relatively low quality of coaches for youth.

Based on this analysis of the situation ("confirmed" by a poor presence of Portuguese athletes in the Seoul Olympic Games in 1988 and by successes of the national youth soccer teams in World Championships in the early 1990s), major sport federations, specifically soccer, basketball, handball, volleyball, athletics and swimming, took several strategic measures to strenghten their position internally and to obtain better results in international youth competitions and, later, in senior championships. Not all of the federations followed the same solutions, but there was a common view of the problems that led to some general options:

- Reinforce the so-called department of Recruiting and Promotion, with the task of increasing the number of young athletes and at the same time, to detect and select those with better aptitudes to that specific sport;
- Reinforce national team programs, which was seen as a tool for development towards quality and a way to achieve international success;
- Create a support program for national teams, based in district organizations, in order to increase the number of elite young

athletes who follow a common training plan (some federations called this "the route to high performance"); and

- Reinforce coach education and training programs in order to support the elite projects.

The suggested solutions to enforce these options were basically three:

- Increase both the number of days spent by the national teams in training camps (national junior soccer teams start to spend more than 100 days/year in training camps), and participation in international competitions;
- Create a competition for district teams for boys and girls 12–16 years of age, where the elite young athletes would practice and compete under the guidance and observation of national coaches; and
- Structure coach education and training program based on "levels" oriented toward the preparation of a high performance coach.

The "elite oriented programs" demanded a huge financial effort, forcing most of the major federations to compete for more money from the government and from sponsors. While the public funds were still dependent on the number of athletes enrolled, all federations retained programs and competitions for young children and adolescents, and encouraged the clubs to do the same. However, the contradiction between "mass" programs for children, mainly through "sport schools" and "mini" sports, and an orientation towards elitism was not solved by the sport federations until the present.

1995-2002: "Super elitism"

The "super elite" model was regarded as a successful since soccer and handball had good results in European and world youth championships, at least until 1995/1996. However, it became obvious for many coaches and federation officials that this was not sufficient. The basic argument was that in order to meet the demands of international performance, practices and competitions only in clubs were insufficient to prepare youth for high level sport (e.g., Portuguese Basketball Association). In order to face progress of other countries, the best young athletes needed to remain in training camp and under national coaches throughout the year. With government support through the High Performance Center, some federations created their own centers, where young athletes 13-18 years lived and practiced together. These youngsters (boys and girls) spent from <300 hours/year of training in clubs to 700 hours/year in performance centers.

It was generally believed by both the government and federations that traditional clubs were in crisis (money and volunteers) and could not face the demands of high performance training programs, and that youth were also in crisis due to too much amusement, sedentarism and hedonism. Because most youngsters come to sport primarily for fun or enjoyment, the quality of athletes and competitions decreased and federations, through national teams, had to take special care of talented individuals.

At the same time, competitions within Portugal were seen more as an obstacle (due to the relatively low quality) than as a way to develop talented young athletes. Therefore, elite young athletes were viewed as needing to compete more frequently abroad and/or to participate in domestic competitions with older athletes (e.g., a 16 year old competing with an 18 year old).

In the same way, professional soccer clubs started to create their own training centers, believing that high performance and competition in a global market demanded a solid and professionally oriented preparation from very young ages (in some cases as early as 10 years). The club version of the Performance Centers is limited to soccer at present because the major clubs have adequate funds.

A critical overview

The dominant concepts regarding youth sports in Portugal are similar to those of other European countries. Sport federations do their job, searching to reach success in international competitions and to increase the popularity of their respective sports among youth. This competition for high performance results and for the "market share" – and also for more funds – is a fundamental task assumed by federation officials. However, the case of Portugal also has some local charateristics:

- Due to weakness of activities, poverty of investments and lack of qualified personnel, the reception and implementation of international trends was late and inefficient in the local conditions in most instances;
- Due to the absence of good school sport programs, clubs and federations were responsible for almost all sports available for youth;
- Due to the lack of collobaration among faculties of Sport and Physical Education, the intervention of professors and sport scientists in the design and control of research into youth sports was not systematically established until the 1990s;

- General acceptance (by almost all coaches and sports officials) that quantity insures quality of athletes;
- When it became evident that something was wrong with youth sport, federations designed programs to emphasize the training process with young elite athletes;
- "Super elitism" (high performance centers) was not anticipated by talent detection programs supervised by sport scientists;
- The need to increase the number of participants in competitions, determined by quantity based criteria for public funding and by competition for "market share", moved federations to start recruiting athletes at younger ages, with new teams, new competitions, more coaches, more referees, more training facilities, more travel, and so on; and
- The convergence of the increasing number of athletes and "super elitism" placed considerable pressure on the budgets of federations, consuming a large part of financial and human resources.

The situation obviously varies among federations. Some are paying attention to changes and listening to sport scientists in order to adapt to the needs of youth and to design new programs and new activities.

SCHOOL SPORT PROGRAMS

The organization of school sport since 1974 shows several inconsistencies, lack of clear policies, and conflict between schools and clubs. In 1974, the sport system – including school sport - was integrated in a department, Direcção Geral dos Desportos (DGD), which was dependent on the Ministry of Education. In 1977, school sport was transfered to so-called "educational departments" in the Ministry of Education. The motives for this change were clearly expressed in Law 553/77: "*School sport is an extra curriculum activity and makes sense only as a logical sequence of the curriculum activity (physical education classes); the intervention in school of non scholar organizations must be avoided.*"

In 1986, school sport returned to the competitive sport system, integrating again the DGD. However, Law 46/86 recognized the specificity of school sport and in 1989 a department of school sport, Gabinete Coordenador do Desporto Escolar (GCDE), was created. It integrated again the educational departments of the Ministry of Education, but was also dependent on the DGD. This solution was based in "the essential unity between physical education and school sport." In addition, "schools have their own specificity", despite the "cooperation that can be established with other organizations."

Sport Law 1/90 and the Physical Education and School Sport Law 95/91 stated that school sport is Sport and has its place in the sport system but, at the same time is "an activity made in school". Therefore, school sport is defined as a "*subsystem totally integrated in the educational system*" and also as an "independent part of the sport system where can be set up relations with clubs and federations", giving however the priority to education.

Subsequently, Laws 143/93 and 115/95 established that the new Sport Institute (INDESP) must support the "competitive activities of school sport" and "coordinate the school sport activities and the correspondent facilities." According to Law 143/93, INDESP was integrated in the Ministry of Education. However, in 1995 Law 269 transfered the Institute to direct dependence on the prime minister, and in 1996 Law 164 withdrew all missions regarding school sport from INDESP.

Until now, the coordination of school sport remains in the Ministry of Education. All of the changes over almost 30 years were the visible face of the struggle led by physical education teachers to retain the power of decision regarding school sport. For most teachers, school sport is an educational activity that must be regulated by the schools and almost exclusively by physical education teachers with no interference from the outside. In the view of many, school sport had to be kept from the interference of the federations which were viewed as elitist.

School sport has an independent competition system. Boys and girls who participate in federation championships are not eligible for school competitions. However, schools can participate in federation competitions and federation athletes are eligible for international school championships!

School sport activities cover the basic and secondary schools, from 5th to 12th grades, under the supervision of a physical education teacher or other discipline teacher with a sport curriculum. The time spent in practices and competitions (4 hours/week) is included in the teacher's schedule, reducing the number of physical educaton classes. The activities are done during school free time and participation is voluntary.

For this reason, school sport is often viewed from the outside as an "island" in the sport system and is often criticized by coaches and federation officials as irrelevant to their goals. Current criticisms, especially on the occasion of some international defeat, are that sport in school does not exist, has poor quality, and does not provide national sport with a large number of young talented athletes.

The actual situation of school sport is one of isolation and discredit in public opinion: no internal activity in school, few participants and competitions, poor quality of athletes and competitions, bureaucracy and exhibition activities. The criticisms previously addressed to federation sport are now applied to school sport. According to Pires (1996), the main problem of school sport is the lack of an objective.

5. RESEARCH ISSUES IN YOUTH SPORTS

Table 3 presents a selection of titles of papers, theses and/or books dealing with different aspects of youth sports in Portugal over the past 20 years. Early research on Sport Science and Physical Education was limited to an educational approach, whereas in the field of sport, studies were mainly focused on performance determinants in a perspective of optimization. Sobral (1984) stressed the importance of studying structural and functional conditions related to the attainment and maintenance of a high level of performance. Subsequently, knowledge developed within several disciplines with interests in sport and physical activity has reformulated prevailing paradigms and guidelines: from athletic related fitness (Araújo, 1985) to psychosocial determinants of sport adherence and drop-out (Serpa, 1990), and from an initial emphasis on biology (Sobral, 1984) to a psychosocial emphasis (Gonçalves, 1990; Marivoet, 2001).

Problems such as elitism, satisfaction of children and youth engaged in sports, motives for coaching activity, coach attrition, retrospective analysis of former youth athletes submitted to intensive training, and others are lacking in the Portuguese literature. Many of these unanswered questions require an interdisciplinary approach.

Table 3. Selection of sport science.

Author	Year	Subject	Title
Sobral	1984	Morphology and sport	PhD thesis
Araújo	1985	Sport talent selection	Article
Sobral	1988	The adolescent athlete	Book
Lima	1989	Premature exclusion of youth athletes	Article
Sobral and Marques	1990	Excellency in youth school population	Book
Serpa	1990	Participation Motivation	Chapter
Gonçalves	1990	Fair-play	Article
Marques	1991	Basis for talent identification in Portugal	Article
Vasconcelos Raposo	1993	Psychological, social and cultural factors that influence goal achievement among Portuguese top atletes	PhD thesis
Maia	1993	Anthropobiological approach on sport selection	PhD thesis
Sobral	1994	Youth sports: readiness and talent	Book
Adelino *et al.*	1999	Youth training	Book
Fonseca and Maia	2000	Motivation of youth athletes	Book
Marivoet	2001	Sport habits in the Portuguese population	Book

Participation in sports is one of the most important dimensions of socialization in contemporary society. Participation in sports is not compatible with unidimensional perspectives that sacrifice the complexity of its nature to the accuracy of experimental methodologies. Sobral (1996) suggested that such broad concepts as sport participation, physical fitness, and lifestyle are first and foremost biocultural topics that are not compatible with the relatively narrow perspectives that persists in some academic communities. Therefore, after a period dominated by non-contextual viewpoints, an era of comprehensive, holistic and temporal analyses is needed.

6. OVERVIEW AND RECOMMENDATIONS

- Although competitive sports are popular, the demands of long-term preparation are being identified as a main factor in drop-out.
- New organizations (mostly coach free) in youth sports oriented by commercial proposals (3x3 basketball, beach volley) have emerged in the past few years. As a result, competitive sports are starting to face a decrease in youth participants. Concurrently, children and youth are being attracted to more and more non-sport leisure activities, such as skate boarding, surfing, electronic sport games, among others.
- Programs oriented towards elitism need to assume alternative strategies to the view that top athletes develop from mass sport participation. By taking this challenge into account, many federations are promoting high-performance centers for talented youth athletes. Unfortunately, these programs are relatively spontaneous and do not ordinarily include sport scientists.
- Youth sport organization would be negatively affected by the promotion of a narrow number of candidates for participation in high-performance levels. The success of talent detection, selection and development depends on the quality of interventions acting long before sport specialization.

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PROMOTING QUALITY IN YOUTH SPORTS

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1. INTRODUCTION: THE CHALLENGE FOR QUALITY

In the last few years, debate among experts and coaches has focused on the quality of youth sport programs. Underlying motivations are the special training needs of children and youth, and the continuous search for better results in sport.

There is no quality in youth sport programs without well-prepared, qualified coaches. The preparation of coaches requires an appropriate theoretical framework based upon knowledge produced by scientific and empirical research. However, much of the research dealing with the practices of coaches has not always been satisfactory and errors have been made based on research.

Several key aspects of the debate on quality in youth sport programs are subsequently considered. In youth sport, quality demands that coaches are prepared to think and understand sport far beyond the immediate results of competition. A coach's commitment to youth sport should be understood within the framework of pedagogical and moral (ethical) responsibility preparing youth for the future.

Parents, communities and society at large expect coaches to be competent and responsible in offering opportunities for youth to practice sport and to develop abilities and qualities under safe conditions within a sound social environment regarding moral and ethical principles. On the other hand, it is not acceptable for coaches, parents and/or staff to use youth activities as an instrument to achieve their own expectations, interests and objectives to the detriment of the developmental needs of youth.

Coaches should be required to improve their practices in the leadership of youth sport programs. They should not only be expected to accomplish specific sport tasks, but should be expected to be responsible and competent to prepare youth for future life. This requires that coaches are familiar with the biological, psychological and social characteristics of growth and development during childhood and adolescence, and can integrate this knowledge into their practice. Coaches should also be prepared to organise sport activities under appropriate pedagogical principles and ethical values. In this way, coaches can prepare young athletes not only for the demands of future top level sport but also for life in general. These tasks are highly demanding from the technical and physical points of view, and also require a strong moral foundation to face the demands of professional sport.

What is a competent coach? Is he/she the one who achieves the best competition results with young athletes? As already noted, results are not the most effective criterion to evaluate the competence or quality of a coach. Other criteria are required.

Meinberg (1991) proposed the following perspective. The competent coach in youth sport programs is not the one who achieves immediate results in competition throughout an early intensive specialisation, but the one who succeeds in bringing to the higher stages of top level sport the great number of young athletes. In competitive sport, results obtained in early stages of youth preparation have no social relevance if they limit the possibilities for advancement through the stages of a sport career. Winning is important for children and adolescents, but it can not be so important for coaches.

If we want to assess coach competence, several questions should be asked. Among the young athletes coached, how many have succeeded, some years later, in reaching the higher stages of top level sport? How many of a coach's young athletes are still involved in top level training?

It was suggested for a long time that simply increasing the number of hours and years of training would, as a consequence, result in better performance in high levels. A direct relationship between training volume and performance quality in advanced stages of a sport career was assumed (Bremer, 1986). The error in this assumption is now being gradually understood. Training strategies based strictly on increasing load volume, with no emphasis on the load quality, led to poor results in advanced stages and perhaps contributed to increasing rates of drop out.

High performance at the top level depends mostly on what was done in the initial stages and not so much on the number of years of training. Top-level results are apparently influenced by the quality of the loads rather than by the number of hours in training. However, further evidence is needed to confirm this assertion. Nevertheless, even if it could not be confirmed, it is necessary for coaches of youth to change this approach.

The daily life of children and adolescents is filled with a variety of activities in education, sport, music, dance, foreign language acquisition, computer training, and so on, in addition to normal social demands of peers and family. These needs are important to youth development and limit the time available for sport training. Coaches should not encourage youth to sacrifice these activities in order to concentrate on sport.

The interests of young people are becoming more and more diverse. Moreover, parents are aware that their child's chance for a successful career in sport depends on the opportunities provided in the first years of formation, but that opportunities for such careers are extremely few.

Hence, the promotion of the interest and enjoyment in sport activities should constitute a priority for coaches (Rahn, 1993). This implies that coaches carefully choose training methods and content.

What motivates a 10 year old child to swim non-stop 2 hours a day, 7 days a week? Is such a monotonous training program necessary for success in swimming? Can the great number of dropouts from such programs be avoided?

Methods based on games are viewed by some pedagogues (Kurz, 1988; Marques, 1995; Rost, 1995) as a very important strategy to promote an athlete development in the early stages of preparation. Marques *et al.* (2000), for example, analysed 981 training units of Portuguese young athletes, 10-15 years, in several team sports - basketball, soccer, team handball and volleyball. In the age group 10-12 years, coaches used most of the time (55%) in training methods not based on the game approach.

Promotion of quality demands the choice of more interesting activities which may bring even more young people into sport practice. It also assumes that coaches will be able to do their best using more effective methods in the particular sport activity to provide better work and to achieve more effective results.

The aim of this paper is to address recent theoretical developments which may help coaches promote quality in youth sport programs. Quality is a word that is part of daily vocabulary, but has different meanings among individuals and contexts. The term quality is in many ways an elusive and abstract concept (Carman, 1990). For the present discussion, the promotion of quality refers to the improvement of the effectiveness of training as suggested by Martin (1991): "for the same work, more effectiveness in the results." The subsequent discussion considers improvement in the quality of training in the context of the following variables: sport technique, decision making processes in sport activity, speed training, training load, and sport competition.

2. PATHS TO QUALITY IN YOUTH SPORT PRACTICES

Both the individual and sport performance are complex realities. Athletic performance depends on bio-psycho-social determinants. The interactions of bio-energetic and informational processes, which are influenced by cognition, will and emotion, are central. However, in most cases, neither the practices of coaches nor the models that underlie the methods are committed to this view. Both theory and practice of sport training focus largely on the "principle of load-adaptation of the bio-energetic systems" (Bauersfeld, 1991). Even if information processes are perceived as an important factor for the practice of a sport, they are often not considered, which is erroneous. This is especially important for children who are learning a sport. These ages are a sensitive period for motor learning in general and for the acquisition of sport fundamentals in particular. Sensorimotor and cognitive aspects need to be emphasised in sport practice during childhood.

As a general principle, training priorities before puberty should be oriented to the informational dimension – decision and co-ordination mechanisms – of the sport activity. After puberty priorities should focus on the metabolic and muscular dimensions (Martin, 1991; Martin *et al.*, 1993; Rost, 1995; Marques, 2000). Accordingly, several aspects of improved quality in the training of children and adolescents are subsequently considered:

- Improvement of sport technique
- Choice of adequate decisions during sport activities
- Improvement of speed training
- Choice of appropriate loads
- Development of the competitive system.

IMPROVING SPORT TECHNIQUE

The process of improvement of sport technique was always considered a major issue in youth training and because of this was regarded in most sport disciplines as a key factor of the activity programs. In general, specific technique models were developed for youth training starting based on the demands of top level sport; technique training became a more and more autonomous training complex in youth sport programs; technique training was being supported by theoretical assertions; and youth competition often integrated complexes of different techniques (Bauersfeld, 1991).

Further aspects of technique training need consideration. First, a major role should be played by movement regulation and control. The demands related to sport technique research and knowledge development, particularly movement representation and perception, should be emphasized. Second, technique training and motor learning should not be viewed from a narrow perspective. On the contrary, they should be organized in an integrative relationship with other motor, decisional and energetic demands of the specific sport activity. However, interactions between the latter and technique training are seldom considered in an adequate manner. Experts and researchers need to more carefully consider these issues, focusing attention on the demands of the coordination and learning processes. Improving quality in the future should be based on defining new training orientations and principles that focus on a continuous increase of the degree of difficulty of the coordination and motor learning demands (Martin, 1991).

EMPHASING THE ROLE OF THE DECISIONAL PROCESSES DURING SPORT ACTIVITIES

In youth programs and particularly tactic/strategy sports, decision making in sport actions should be a major objective. It is very important that in all stages of the process of sport preparation, young athletes can play an active and conscious role in the learning and training. This implies that coaches focus more on situations that can be stimulating for learning and that can help youth to choose adequate options during sport activities. It also implies that coaches do not always provide youth the answers needed to resolve the problems they face in sport activities. Coaches must be able to objectively define what they want youth to learn in each stage of the training process and to help youth to make the right decisions by formulating the principles and orientations that guide decision-making. This will promote a more effective learning/decision making process.

A great variety of the activities offered to youth in training and competition are not the most adequate and do not properly stimulate the sport learning process. They are often too complex for youth who are not yet either able or prepared to respond to these demands. Team sports, for instance, require attention, anticipation, decisions and quick responses, which are cognitive competencies that are not completely developed in children under 10 years of age (SMPC, 2000).

Good learning processes are those that stress active and conscious participation by setting problems and providing youth with opportunities to experience a diversity of situations, e.g., rejecting some options and choosing others among the possible solutions, and not those that are strictly dependent on feedback from coaches, as happens very often. Using the example of team sports, if a coach wants athletes in top level stages to respond quickly and correctly to game demands, he/she needs to prepare them appropriately since the early stages of the learning/training process. The athletes should be prepared to respond with short reaction times and in reduced game areas because time and space for play are not readily provided by opponents.

INCREASING MOVEMENT'S SPEED DURING SPORT ACTIONS

Speed training is a priority in many youth sport programs (Bauersfeld, 1991; Martin, 1991; Rost 1995; Marques and Oliveira, 2001). However, some coaches do not focus on speed abilities.

An analysis on the structure of training sessions of young Portuguese athletes 10-12 years in several team sports indicated that speed abilities play a minor role – only 5% of training's total time, 2.5% to reaction speed, 0.7% to movement speed and 2.3% to maximal speed (Marques *et al.*, 2000). Because speed abilities are important to the formation of young athletes (Bauersfeld, 1991; Martin *et al*, 1993; Martin, 1999), they should be prioritized in close relation to technique and tactic/strategy formation. However, this happens neither on a regular basis nor in the proper manner. Most of the time, emphasis is oriented to the muscular and metabolic components of speed and less to the aspects that depend on control and regulatory mechanisms of the nervous system. The latter emphasis is more adequate for children because at this stage are in a sensitive period for the development of coordination processes.

Maturation of the nervous system takes place earlier than the maturation of the metabolic and muscular systems, which are generally ready to support intensive loads after puberty. The development of the functional mechanisms of neuromuscular and nervous systems which control fast movements do not occur in a natural manner, i.e., as a maturation process (Rost, 1995). On the contrary, they occur in close relation to the activities that children experience during this period of development. Thus, if a coach wants to stimulate these mechanisms, appropriate situations should be selected. This can be done, for example, by adopting competitive models that reduce the game area (small games) or by reducing the distances.

In Germany, young long distance swimmers compete often over short distances such as 25 or 50 meters no matter the stroke. In the United States, young swimmers do not ordinarily participate in long distance competitions (Rost, 1995).

The improvement of speed training methods should be understood as a major priority in youth sport because this ability is a determinant of top level performance in most sport disciplines. But before puberty, training methods should stress the information systems in relation to the sensitive period of coordination and sport technique.

The development of a superior organisation of the nervous system and the stimulation of neuromuscular regulation and control mechanisms through fast and intensive sport movements should be done during maximal load exercises and movements under time pressure, as happens during competitive situations. However, these kinds of situations also increase the number of coordination errors. As a consequence, coaches need first to assure correct execution of motor skills and sport techniques. The degree of complexity of many competitive actions and exercises, and the low level of development of the energetic and muscular systems do not always allow specific speed training based on competitive exercises. Taking this into account, the strength demands of speed exercises can be reduced and exercises that allow higher movement speed can be emphasized so that youth can easily and quickly identify and respond to game demands (Bauersfeld, 1991). The importance of a systematic improvement of intra- and inter-muscular coordination throughout fast muscle contractions during situations of reduced resistive training should be emphasized (Martin, 1991).

In such situations, motor transfer to specific sport practices is not negatively influenced if the training exercises are similar to the competitive activities. This is why loads under time pressure should be used on a regular basis in youth sport programs in all training situations and not only during speed training.

CHOOSING THE MORE APPROPRIATE LOADS

Results in high level stages do not depend on the continuous increase of load volumes in youth programs. There is a need to better identify appropriate loads for youth training. This requires more careful choice of both load and content of training (Martin, 1991). In an attempt to build of a new model for training loads in youth sport programs, four main orientations are suggested:

(i) Preparing young athletes to support high loads in top-level stages

Good results in top level sport should not be expected without very intensive loads. Young athletes need to be prepared to support such loads when they reach advanced stages. By using multilateral loads in youth sport programs, coaches can enhance and strengthen the basis that allows, some years later, the application of very intensive loads. This will presumably improve results and reduce impacts of such loads on the body.

(ii) Stressing a specific multilateral load

Some formulations of training theory suggest that the adaptive potential of the organism is limited to so-called "adaptation reserves" (Martin, 1991). For this reason, the spectrum of factors to be trained must be limited to the relevant demands of a competition in the specific sport. General training should thus aim at the specific demands of each sport (Bauersfeld, 1991; Rahn, 1993; Marques, 1999; Marques *et al.*, 2000).

Accordingly, coaches need to use multilateral loads by increasing the capacity levels of specific performances through the choice of appropriate exercises. Such a program promotes both the objectives of general training and transfer effects from general to specific exercise.

(iii) Focusing on quality of training loads

Improving the quality of training loads requires concentration on those components of the performance which are essential for top level sport in each discipline. These components are understood as pre-requisites for the opening of new reserves of sport performances which are not properly stimulated during the formation stages.

If these components have such an essential role, they need to be defined for each sport discipline and the periods (times) when they can be properly stimulated during the long term process of athlete development need to be identified. If specific training does not take place during these particularly sensitive periods, it will be likely very difficult to do so later.

(iv) Individualisation

Finally, the focus on quality also requires the establishment of conditions that allow a stronger individualisation of the coaching process (Martin *et al.*, 1993). Such individualisation is one of the major possibilities for promoting quality.

THE DEVELOPMENT OF THE COMPETITION SYSTEM

The increasing social relevance of youth sport over the last four decades or so and the search for better solutions to the process of sport specialisation has resulted in the development of a youth competition at the regional, national and international levels. Although youth training systems have improved, the same cannot be stated about the system of competitions. There is a lack of theory dealing with youth competitions. In most cases, competition models are very traditional and conservative. They are quite similar in organisational form and content to competitions in top level sport. This is unfortunate because the demands of these competitions are very high and the possibilities for child and adolescent athletes are not the same as for adult athletes.

More precise formulations of a competition theory for youth are needed. These may include, among others, the following:

- Function and objectives of youth sport competitions
- Types of competitions for different stages of development and preparation
- Number and frequency of competitions during each phase of sport formation
- Organisation, regulation and content of competitions at different stages of sport preparation
- Relationships between training and competition at different stages of sport preparation.

There is much work to be done to improve the quality of youth sport competitons. This will require the contributions and efforts of researchers from all disciplines of the sport sciences and experts in youth sport in building of a sound competition theory.

Training and competition are the two main subsystems of sport, and by definition they are related. Theories and models of training and of competition for children and adolescents need to be developed jointly.

Continued application of the specialized competition models of adult and top level sport to youth will undoubtedly result in premature specialization of children and adolescents. The specialised demands of competition with emphasis on results necessarily requires specialisation of the training process, which has as a consequence premature increase of load volumes and intensities to levels that are not appropriate for children and adolescents and for the objectives of youth sport formation. Overuse injuries and other negative implications for development and health are often outcomes of such efforts.

As a result, several European researchers and pedagogues have focused on the contents of competitive activities during early stages of development in an attempt to formulate a more adequate and harmonious relationship between the contents of training programs and the contents of competitive activities (Thieß, 1991, 1995; Rost, 1995; Tschiene, 1995, Marques, 1997; Lima, 2000; Marques and Oliveira, 2002). If both training and competition in youth sport programs are to be understood primarily as a means for formation, the practice of training and competitive exercises needs to be brought into the same framework.

Pedagogical guidelines for the early phases are oriented to the idea of diversity in activities and are aimed at promoting multilateral development. The same should occur in competitive sport activities. They should be considered as a training means, constituting a highly motivating stimulus to children and offering them the chance to participate in a variety of competitive activities, either formal or informal, highly structured or unstructured, in accordance to the objectives of sport formation during the early stages.

In summary, in each phase of the long term process of sport preparation, there should be a balanced, coherent relationship between the content of the activities in training and in competition according to the following orientation:

- Stages of multilateral training - multilateral competitions,
- Stages of adapted specialised training - adapted specialised competitions,
- Stages of highly specialised training - highly specialised competitions.

3. OVERVIEW AND IMPLICATIONS FOR TEACHING AND COACHING

The debate on the quality in youth sport programs will continue. Many other topics contribute to make this debate more significant. It is important to be aware that children and adolescents in sport are the subjects and not only the objects of intervention by coaches. Implications for teaching and coaching include the following, among others:

- Continued improvement of teaching and learning methods of sport techniques focusing on movement regulation and control processes and emphasising the role of movement representation and perception. On the other hand, technique training should be planned in an integrative manner with other demands of sport activity.
- Emphasis on the role of decisional processes during sport activities by setting appropriate problems and providing opportunities that offer children and adolescents possibilities to choose the best solutions during each situation.
- Give speed training high priority in youth sport programs by focusing on control and regulation mechanisms of this ability during childhood rather than on the metabolic and muscular mechanisms, which should be emphasised after puberty.
- Choose more appropriate training loads in youth sport programs by planning load dynamics according to three main principles: (a) children and adolescents should be prepared to support very intensive loads in top level stages; (b) multilateral loads specifically oriented to the specialised demands of a chosen sport should be

used; and (c) focus should be on the quality of training loads by identifying those components of top level performance which are essential to top performance and work on them during the right periods of the long term process of sport formation.

- Finally, emphasize the fact that adult competitions are much too demanding for children and adolescents, and that competitive activities in youth sport programs should be organised according both to formation objectives and the needs of the young athletes.

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YOUNG BODIES IN SPORT: BETWEEN THE ASCETIC «HARD WORK» AND THE NEW WAVE «JUST DO IT»

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1. INTRODUCTION

This paper provides a critique of the processes by which health, exercise, and the body have emerged and moved on the cultural agenda of young people. Contemporary life has transformed the body into an object, as a material of ideal appearance and depository of social norms and rules. It is argued that the development and promotion of cultural beliefs among young people flow from and help to reproduce discourses about the human body as a perfect image. Of interest is the body-young person relationship, specifically when young persons address this relationship in the context of the ideals and models of contemporary western culture. This idea is explored through three discussions organized around the theme of the construction of a new subjectivity of young people:

- First, how health is embodied through sport practices, and how it is used in the formation of a new self by young people is initially summarized;
- Second, the link between sport for young people and the concept of healthy lifestyle and the meaning of contemporary healthy behaviour are critically examined; and
- Third, construction of the self is examined, specifically that young people are lead to inclusive and/or exclusive systems of normalization on the basis of cultural patterns, ascetic behaviors (strict diet, severe training, etc), and/or new ethic regimes (focus on the body, lifestyle, etc.).

2. THE MYTH OF THE ASSOCIATION OF THE PERFECT BODY/HEALTHY BEHAVIOUR AND THE EMBODIED SELF

The body has never been as present in daily life as it is today. In recent years, the public sphere is rooted in a body creed: magazines, television shows, newspapers, advertising, and medical discussions are full of information about how to diet and exercise, and how to transform the body through a variety of expert or common sense solutions. Never before in history have images of the cultural ideal progressively blurred the boundaries between beauty, health and physical performance. The strong emphasis in contemporary culture on the ideal appearance of the body is such that young people are socialized in the myth of a perfect body and healthy behaviour. Attention to body care has been established based upon imperatives of self-realization and the inculcation of social obligations and norms.

The body has become the depository of social rules and order beginning in childhood. The real force of the ideal model of a perfect body and health is linked to the connection between an aesthetic ideal of the body and the ethical evaluation of a person. In this sense, the myth of body perfection is always a problem of control and self-control. The idea that the body can be controlled as an object is particularly evident in the case of those who are able to follow diets or train in sport. Within this context, individuals seek to construct a meaningful sense of self through personal effort and control. The involvement of young people in sport programs, especially in individual sports, provides access to discourses connecting the body with self-identity. In fact, many youth sports programs promoted by the private sector or the state, including schools, encourage young people to care for their bodies in pursuit of perfect health.

This contemporary "healthism" produces a medicalization of everyday life in such a way that two main groups can be identified in the young population: (1) those whose main goal is to construct and present themselves to others as healthy, and (2) those who cannot, or who refuse, to come close to the healthy ideal. In this regard, Blaxter (1993) writes that for the contemporary era, exposure to health risks has become a central marker of social class. While all may blame themselves for their health, only some enjoy a social position that allows them a viable measure of real control over their lives. The author reports that regardless of class and education, respondents notice voluntary behaviours as the cause of diseases: "my life is unhealthy because I can't control my weight, because I smoke; it is healthy because I take exercise, because I watch my diet" (Blaxter, 1993, p. 125). The linkage of health, personal virtue, and self-sufficiency mystifies the structural bases of inequality. By focusing on individual lifestyle as a major determinant of health, "sporting healthism" creates the illusion that people are equally able to make free choices about their health.

At the core of this relatively new health management is the socially pervasive association between health and lifestyle. Health promotion obscures people's differential capacity to purchase the goods that involve healthy behaviours. When access to sporting goods is unequally distribued by class, the real winner of the ideology of healthism is the educated middle class.

Lifestyle and self-improvement are components of a predominantly middle-class habitus that contributes to acquiescence to the logic of inequality (Gomes, 2002). It also exemplifies the replacement of public concern with individual choice as a form of legitimate spread of disciplinary body techniques. Previously confined to disciplinary institutions such as the school in the form of physical education, contemporary individuals are encouraged to live as if making a project of themselves. They are encouraged to take responsibility of their bodies, to work on them as a health guardian, and to invest in a lifestyle that will maximize the worth of their existence to themselves.

The other side of the depreciation of physical education in the schools is the increase in the number of gymnasia as a direct result of the body consumer culture, or the domestication of physical activities by means of personalized machine forms of exercice (Gomes, 2002). Evidence suggests that the implementation of such private projects is constitutively linked to the rise of expert languages. The proliferation of new magazines, self-help packages, and exercise videos has resulted in a new alliance between professionals claiming to provide rational answers and individuals seeking to shape a lifestyle in the hope of personal recovery. By means of educational politics the European states underestimate public support to physical education and sport. State bureaucracies are no longer needed to enjoy healthy habits of exercise. The ethic of lifestyle has infused a private domain that so long appeared resistant to the population rationale. This new relationship operates through cultural technologies of advertising and marketing that have employ a constant and intense self-scrutiny in terms of images of the self.

In a medicalized society, physical activity is presented as the best way to control the body and in turn life. Bodies in control and bodies out of control become, not only a physical marker, but also an ethical focus, the only way to reach self-responsibility. The attribution of social responsibility to the proactive pursuit of health to individuals moved forward since the healthism of the early 1970s when themes of individual effort, discipline and will came together with a deregulation of public health programs. Such thinking is typical of countries which are attempting to replace old models of regulating health. Instead, individuals are encouraged on the assumption that they want to be healthy and freely choose the ways of living most likely to promote their own health. Part of this politic is based on the social body metaphor, the view that social illness may be repaired by disciplinary action on the individual body.

Experts have indicated how to be healthy by means of exercise and prudent behaviour. The normalizing ethical power of the model is proposed by a rhetoric of free choice and personal autonomy. In this context, the practice of sport by young people is justified as a means to avoid drug and alcohol abuse, smoking, and other unhealthy deviant behaviors. Many of these changes appear particularly promising for the social regulation of the current generation of young people, resulting in two apparently contradictory types of sporting values:

- An ascetic lifestyle devoted to hard work, self-restraint and discipline: Framed in the attraction of a thin but muscled body, the middle- and upper-classes strive to physically distinguish themselves as capable of clean living and working out. Training regularly, participation in fitness programs, and/or practice individual sports, often with a personal trainer, demonstrate the evidence of moral and physical superiority over subordinate groups of working class.

- A new ethic regime based upon a new "prudentialism" (O'Malley, 1992): Using the technologies of consumption, the market exarcebates anxieties about the individual's own future to encourage him/her to invest in the quality of life. The ethics of lifestyle maximization, coupled with the supply of new technologies of lifestyle management (what to eat and drink, where to exercise and what to do, what to wear, etc.) generate a relentless imperative of self-government. From this point of view, training and the practice of sport are not neutral activities, but a means of individual development or self-realization. Subjects work on themselves, not in the name of norm conformity, but for autonomy.

The dichotomy of dependency and control becomes a powerful psychological formula for judging the conduct of others and also of one's self. Self-esteem, self-control and locus of control are psychological concepts that invade the discourse of training young people in sport. The prevailing image of performance in sport is of an individual in search of meaning and fulfillment. The world of sport, both competitive and leisure, is conceptualized as a realm in which productivity is enhanced through active engagement of self-fulfilling impulses and desires. "Become whole! Become what you want to be! Just do it!" have replaced earlier ascetic values of competition and hard work.

A survey of sporting leisure practices of University of Coimbra students in 2001 (Gomes, 2002) highlights the importance that individuals place on health and psychological well-being compared to other reasons for participation in physical activity. "To keep the body shape," "to become thin", and amusement are other reasons with some importance for practicing sport during leisure. In addition, females place more importance on weight control, whereas males emphasize the quest for muscularity, which indicates gender differences in concern for body fitness.

This is the modern image of self-obsession, a model of personal recovery that promises to solve social problems, including health problems. The body is not only the material object of training, but also the fundamental symbol which indeed is felt and deployed as a sign of personal worth. Thus, exercise and sport are symbolic domains through which individuals construct and present their identities.

3. BODIES IN SPORT AND HEALTH RECONSIDERED: INCLUSION AND EXCLUSION

The body is an outcome of a particular cultural, scientific, and technical history. Mauss (1973) proposed the notion of "techniques of the body," to stress the social nature of bodily practices, a kind of body *habitus* that varies according to societal factors such as education, propriety, fashion and prestige. Mauss (1979) takes the modern notion of the person as a symbol of a particular cultural elaboration of personhood and a particular cultural model of distributing personhood to individuals. This is the result of ethical techniques which, after Foucault, were called technologies of the self (Foucault, 1988). It was the mastery of these techniques that allows individuals to consciously relate themselves as subjects of their own behaviours and capacities.

In this view, the unitary notion of the body might be abandoned. Rather than speak of an entity intrinsic to the body, a particular body regime is produced to understand assemblages which induce a certain relationship to the individual as embodied, which, in turn, renders the body a totality. In other words, agency is itself an effect, an outcome of particular technologies that invoke human beings as a corporeal reality. This relationship can be established with many modes: confession, solicitude, body care, safeguard, self-esteem, among others which reveal different relationships to authority.

Much of the recent emphasis on health is rooted in the body shape metaphor. New images of subjectivity proliferate like the relatively recent preoccupation with physical appearance and obession with thiness. Expectations for individuals to impose controls upon their bodies have existed to greater or lesser degrees throughout history. In this respect, some social historians (Gilman, 1988, 1995) have explained that shifts in body ideals and in the attachment of moral values to health lie in anxiety about illness, and moreover, anxiety about the presence of the "dangerous others" and the risk of their diseases. Consider, for instance, the relationship to authority that governs the historical configuration of mental health and madness as exemplified in the mastery that exercised between asylum doctor and hospitalized individual in late eighteenth century, in the institutional discipline in the nineteenth century, and the pedagogy of mental hygienists in the first half of the twentieth century.

Present day society appears to be marked by focus on control over image as a major determinant of health. Exercise becomes a response directed to regaining control. Subsquently, ilness has increasingly come to be associated with insufficient resolve to exercise, to quit smoking, to eat well, and so on. Sick people are now more often blamed for being ill (Shilling, 1993), and failure to be self-surveillant about health is often defined as deviant (Crawford, 1980), and obesity is often attributed to a lack of will.

Thus, attribution of an inclusive aim to sport and physical activities of young people may be misunderstood. Despite the best professional intentions, no principles are ever totally inclusive. Rather, they are based on principles of division and differentiation. The social significance of systems of inclusion and exclusion is apparent when physiological, anthropometric, and pedagogical knowledge is viewed as a strategy to order and at times divide children and youth in sport. These scientific discourses offer particular sets of local norms as global, constructing a particular normalized space. The normalization involves multiple sets of linkages. Notions of children's potential, capacity, growth, motivation, ability and talent are linked to other sets of ideas about weight, height and other performance and physiological parameters that establish the average. The language of these parameters can be viewed as a system that constitutes rather than reflects, that prescribes as well as it describes: "being normal" is a statistical construct.

The discursive relationships between scientific and cultural categories embodies unarticulated rules that inscribe social and cultural norms of body image into principles of training and pedagogical intervention. These systems of inclusion/exclusion are also cast through an asymmetrical relationship. Certain discourses stress ethnic/racial or gender differences assuming a certain unity based on populational reasoning. The presence or absence of some biological or psychological features are used to specify what the individual lacks, and with proper training, these can be modified into positive qualities. New modes of subjugation produce new modes of exclusion and new practices for reforming individuals so excluded.

The technologies of knowing one's self sometimes constrain and repress the manner in which children and youth experience their bodies in sport. Data on the pervasiveness of disordered eating behaviors among female athletes illustrates the normative power of some biological signs. The American College of Sports Medicine estimates that as many as 65% of females competing in figure skating, gymnastics, synchronized swimming, and endurance sports may suffer from disordered eating. Although some male athletes use extreme methods to lose weight (e.g., to meet a weight category in wrestling), these behaviors are especially true of sports that require an aesthetically pleasing female figure. There is also growing evidence that for some individuals, exercise can become a compulsive behaviour.

In this sense, the social value of women has become associated with their bodies and is expressed through the ideal of slenderness. Thinness has not only come to represent attractiveness, but also has come to symbolize self-control, moral integrity, and higher socioeconomic status (Marzano-Parisoli, 2001). This orthodoxy tends to result in an ascetic approach to sport and the body, convincing more and more individuals that they can modify and build the body that they desire.

These messages make the myth of will and moral fortitude more powerful. Despite these claims, all individuals cannot have the body they desire. The other side of this practice reveals two extremes: exercice addiction and food refusal on one hand, and bodies that resist normalization on the other hand. The first is based in the ability to tolerate bodily pain and exhaustion. Bordo (1993) emphasizes that disordered eating proliferates in such a cultural climate. The second one is formed by those who fail to engage in prudent behaviour, regular exercise, and maintenance of a desirable weight. In the survey of University of Coimbra students (Gomes, 2002), those from families with low income and low educational attainment engage less often in regular sporting during leisure. On the other hand, students from high income families more often emphasize the belief of a connection between exercise and health status. These disparities based by family education and income suggest an effect of culture on physical activity and beliefs about health status.

4. OVERVIEW

This discussion has criticized the negative effects of having a naïve association between sport and health. Nevertheless, evidence clearly supports a beneficial influence of regular physical activity on health (Shepard, 1995). Given that the majority of the young Portuguese population currently engages in relatively little physical activity, there is a need to explore how far the popular beliefs of the relationship between exercise and health exerts a general effect on exercise expectations and needs.

This, however, was not the point of this discussion. Rather, the objective was to show that an adequate and comprehensive analysis of these problems requires examination of both biological and sociocultural factors. There are many social and cultural factors which account for why some people are more engaged in competitive sport and leisure physical activity than others. Some disengaged behaviours as forms of body resistance and contestation of the hegemonic corporeality regime are identified. Analysis of the forms of contestation, i.e., not to be physically active can be a form of resistance, that can help in understanding ways in which something new is created. This does not imply that regular exercise, competitive sport and physical education are unimportant, but suggests that something might be learned from young people who refuse to codify themselves.

Several contradictions that lie on the relationship between exercise, body shape, and health are indicated. The recent shift in curriculum and research agendas of the physical education, kinesiology, and sport professions toward health care are revealing. Many of these recent shifts, including the re-naming of departments and faculties, connote a rational approach to exercise and health and a self-evident belief that healthy behaviour is beneficial, deflecting, at the same time, attention from structural and environmental factors affecting health. The dominant beliefs about the ideology of healthism need debate. Physical education was historically involved in the hygienist movement since its origin, and at times quite rashly. The contradictory possibilities of health movements exist because these represent a contested terrain over which there are struggles to determine the form, meaning and legitimacy of using the body. Sport and physical activity are part of this process and debate.

In closing, the following summarizes the highlights of this discussion:

- The strong emphasis of contemporary culture on an ideal appearance of the body is such that young people are socialized into the myth of a perfect body and healthy behaviour.
- Contemporary "healthism" produces a medicalization of everyday life in such a way that two main groups in the young population can be identified: those whose main goal is to construct and present themselves to others as healthy, and those people who cannot, or who refuse, to come close to the healthy ideal.
- At the core of this new health management is the socially pervasive association between health and lifestyle. Health promotion obscures individuals differential capacity to purchase the goods related to healthy behaviours. Lifestyle and self-improvement are components of predominantly middle- and upper-class status.
- In a medicalized society, physical activity is presented as the best way to control the body and quality of life. Bodies in control and bodies out of control become, not only a physical marker, but also an ethical means to attain self-responsibility.

- Late modernity society is characterized by self-obsession, a model of personal recovery that promises to solve social problems, including health problems, not viewing inequality, but against the order of the self and the way we govern our selves. The body is not only the material object of training, but also the fundamental symbol which indeed is felt and deployed as a sign of personal worth. Thus, exercise and sport activity are symbolic domains through which individuals construct and present their identities. The dichotomy of dependency and control has become a powerful psychological formula for judging the conduct of others, and for judging one's self.
- Much of recent emphasis on health is rooted in the body shape metaphor, a new image of subjectivity based on physical appearance and an obsession with thinness. Focusing on control over the image is a major determinant of health. Exercise has become a response aimed at gaining or regaining control. Subsequently, illness has increasingly come to be associated with insufficient resolve to exercise more, to quit smoking, to eat well, and so forth. Thus, attribution of an inclusive aim to sport activities of young people may be misunderstood.
- The linkage of health, personal virtue, and self-sufficiency mystifie the structural basis of inequality. By focusing on individual lifestyle as a major determinant of health, a sporting "healthism" creates an illusion that individuals are equally able to make free choices about their health and related behaviours including physical activity and sport.

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Part 2:

PARTICIPANTS, COACHES AND PARENTS

BIOLOGICAL AND SOCIAL RELATIONSHIPS IN PARTICIPATION MOTIVATION IN YOUTH SPORTS

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1. INTRODUCTION

Participation in sport is a common feature in the lives of children and adolescents throughout the world. The form of participation, however, varies from informal sport activities (e.g., a game of football (soccer) among neighborhood boys) to recreational sport (e.g., basketball or volleyball at a recreational center) to organized sport (e.g., regular practice and competition with a formal team or club). Organized sport implies the presence of a coach, and regular practices and competitions during the course of a season. The structure of sport programs for children and adolescents varies among countries (De Knop *et al.*, 1996) and sport opportunities vary with cultural context. An issue of central importance for those who directly work with youth sport programs is understanding why children and youth participate in sports.

Initial insights about the motivations of children and adolescents for participating in sport are based largely on data for North America (Gill *et al.*, 1983; Gould *et al.*, 1985; Ewing and Seefeldt, 1988). Recent information for urban Mexican youth 9-18 years is provided by Siegel et al. (this volume).

Corresponding data on motivations for sport among Portuguese children and adolescents also emerged in the 1980s. For example, the Portuguese version of the *Participation Motivation Questionnaire* was adapted by Serpa and Frias (1990) and published by Serpa (1992) as QMAD. It was preceded by another Portuguese version from Cruz and Cunha (1990) which was mainly used by Cruz and psychological researchers from University of Minho (Cruz and Costa, 1988; Cruz *et al.*, 1988; Cruz and Viana, 1989). The QMAD was used in Lisbon (Costa, 1992; Varela-Silva, 1993), Oporto (Serpa, 1992; Fonseca and Fontaínhas, 1993; Costa, 1991; Fonseca and Ribeiro, 1994), Vila Real (Vasconcelos Raposo and Figueiredo, 1997; Vasconcelos Raposo *et al.*, 1996), and Azores (Ávila and Vasconcelos Raposo, 1999).

Information regarding features of sport participation in the Portuguese Midlands is lacking. The present study considers sport participation and motivation for participating in sport among secondary school students of the district of Coimbra. Sport participation status is initially described and then motivation for participation in sport is considered in several contexts:

- The factor structure of motivation for sport;
- Sex differences in motivation for sport;
- Motivation for sport by current sport participation status; and
- Potential association of somatic variables and social stimuli for sport with motives for participation in sports.

2. METHODS

Motives for participation in sport were surveyed as part of a mlore detailed study of growth status, physical fitness and lifestyle of adolescents in the Coimbra region of Portugal (Coelho e Silva *et al.*, 2003).

Sample

A sample of 797 high school students (387 males and 410 females), 15.5 to 18.4 years of age was surveyed. The students were enrolled in 15 schools of 10 different municipal districts.

Variables

Estimates of sport participation status were obtained with questionnaires. Participation status in organized sport was initially established: status (never or non-participant: NPI; former athlete: FA; current athlete: A). Motivation for sport was assessed with the 30-item questionnaire of Gill *et al.* (1983). The questionnaire was designed to include possible reasons that youth might have for participating in organized sports programs. The respondents were 1,138 males and females, 8-18 years of age, who were participants at a university-sponsored summer sports school program in the state of Iowa (Midwest), United States, in 1979. The Portuguese version developed by Serpa (1990) was adopted for the present study. Respondents were asked to rate the importance of each item on a five point Likert scale (1=not at all important, 3=somewhat important, 5=very important).

Somatic variables included body weight, height, body mass index, sitting height/stature ratio, androgyny index, and sum of skinfolds (log transformed). The measurement protocol described by Lohman *et al.* (1988) was used. All subjects were observed by the same anthropometrist. Technical errors of measurement are reported in (Coelho e Silva *et al.*, 2003).

Social incentives for sport included spatial stimulus, material play stimulus and social participation. This inventory was developed by Renson and Vanreusel (1990) and adapted by Sobral (1992). It included settings and opportunities for informal activities and more formal participation in sports.

Analysis

Exploratory factor analysis of the motivation for sport questionnaire was carried out to identify combinations of items that best explained the variance in the sample. Gender differences were with the t-test. MANOVA was used to test the effect of sport participation status on extracted factors within each sex. This technique is a multivariate extension of univariate analysis of variance, and inquires if there are significant differences among groups for a linear combination of measured dependent variables, combined so as to separate the groups as much as possible. Multivariate analysis was followed by ANOVA and the Bonferroni adjustment for multiple comparisons.

Canonical correlation analysis was performed to analyse the relationships between sets of variables. It is a bivariate correlation between two composite scores (one for each of the two variable sets). The easiest way to understand canonical correlation is to think of multiple regression. In regression, there are several variables on one side of the equation and a single variable on the other side. Canonical correlation analysis identifies the components of one set of variable that are most highly related (linearly) to the components of the other set of variables. The variables are combined to maximize the relationship between the two variable sets. This maximization is performed by weighting initial scores in each variable set. The weights can be either negative or positive and are simply multiplied times the scores for each subject. These weights are called canonical variates and are the same as beta in a regression analysis. Canonical correlation analysis creates linear combinations between sets of variables. Although mathematically viable, linear functions are not necessarily interpretable. Thus, a major challenge using the technique is to discern, if possible, the meaning of pairs of canonical variates. According to Tabachnick and Fidell (1996), the number of statistically significant pairs of canonical variates is often larger than the number of interpretable pairs, especially if the sample is large.

Statistical significance was set as $p<0.05$. The statistical analysis was performed using the *Statistical Package for the Social Sciences* (SPSS inc., version 10.0, Chicago, Illinois).

3. RESULTS

SPORT PARTICIPATION

Among boys, 120 (31%) indicated no history of participation in organized sport, while 120 (31%) were formally involved in organized sport but not involved at the time of the survey, and 147 (38%) were currently involved in organized sport. Corresponding data for girls indicated a major sex difference. The majority of girls, 235 (57%) indicated no history of participation in organized sport and 138 (34%) were formally involved in organized sport. Only 37 girls (9%) were actively involved in organized sport at the time of the survey.

Football (soccer) followed by basketball was the most popular team sport in both sexes, whereas swimming followed by athletics (track and field) were the most popular individual sport in both sexes (Table 1).

Table 1. Popularity of sports by gender.

Boys		Girls	
Sports	N	Sports	N
Soccer	129	Swimming	50
Basketball	30	Soccer	40
Swimming	28	Basketball	18
Athletics	14	Athletics	16

MOTIVES FOR PARTICIPATING IN SPORTS

Results of the factor analysis of the motivation for sport questionnaire in the total sample are summarized in Table 2. Six factors were extracted (eigenvalue >1.0), explaining 53% of the variance. They can be characterized as follows: F1: *Achievement Status* (AS), F2: *Sport Goals* (SG), F3: *Team Orientation* (TO), F4: *Exertion* (EX), F5: *Fun* (F), and F6: *Social Influence* (SI).

Two items loaded on more than one factor, item 20 ("I like to compete") and item 10 ("I want to learn new skills"). Loadings of both items were >0.40, which is the commonly accepted cut-off value for inclusion of an item in the interpretation of a factor. Given the nature of the context implied in each, item 20 was included in F1 (Achievement Status), while item 10 was included in F2 (Sport Goals). On the other hand, three items of the motivation for sport questionnaire did not meet the criterion for inclusion on any of the six factors: item 12 (0.39), "I like to do something I am good at"; item 22 (0.34), "I like being on a team"; and item 26 (0.37), "I like the challenge."

Table 2. Factor analysis on motives for participating in sports. Communalities and loadings on extracted factors after varimax rotation (N=797).

	Communalities	F1	F2	F3	F4	F5	F6
1. I want to improve my skills	.47	.06	.60	.32	.05	-.06	-.02
2. I want to be with my friends	.62	.10	-.09	.34	.04	.69	.07
3. I like to win	.51	.65	.28	-.01	.03	.00	-.06
4. I want to get rid of energy	.63	.08	.17	.14	.76	-.02	.01
5. I like to travel	.45	.32	-.15	-.06	.37	.41	.13
6. I want to stay in shape	.51	.01	.66	.00	.22	.17	-.02
7. I like the excitement	.44	.32	.12	.18	.50	.18	.04
8. I like the teamwork	.60	-.03	.18	.72	.16	.14	.04
9. My parents or close friends want me to participate	.46	.25	-.11	.38	.11	.20	.43
10. I want to learn new skills	.48	.08	.42	.53	.12	.08	.07
11. I like to meet new friends	.64	.03	.03	.39	.20	.66	.04
12. I like to do something I'm good at	.39	.32	.29	.07	.35	.26	.10
13. I want to release tension	.58	-.08	.28	.09	.67	.05	.17
14. I like the rewards	.58	.73	.11	-.04	.12	.11	.04
15. I like to get exercise	.52	-.18	.61	.08	.27	.05	.20
16. I like to have something to do	.58	.11	-.01	-.08	.32	.15	.66
17. I like the action	.47	.08	.27	.09	.34	.12	.50
18. I like the team spirit	.62	-.09	.26	.71	.10	.12	.15
19. I like to get out of house	.43	.46	-.23	-.13	.17	.25	.24
20. I like to compete	.50	.42	.47	.24	-.09	-.03	.18
21. I like to feel important	.58	.73	-.11	.07	.10	-.01	.13
22. I like being on a team	.34	.20	.16	.34	-.05	.33	.22
23. I want to go to a higher level	.57	.33	.64	.19	.00	.02	.12
24. I want to be physically fit	.58	-.09	.73	.12	.14	.02	.06
25. I want to be popular	.60	.75	.04	.02	.02	.06	.18
26. I like the challenge	.37	.17	.38	.31	.19	.00	.25
27. I like the coaches	.61	.38	.15	.33	-.09	-.06	.57
28. I want to gain status or recognition	.64	.77	.03	.10	-.02	.01	.18
29. I like to have fun	.67	-.05	.29	-.12	.00	.73	.18
30. I like to use the equipment or facilities	.42	.17	.20	.17	-.09	.14	.55
Eigenvalues		3.86	3.39	2.41	2.12	2.09	1.97
% of variance	52.8	12.9	11.3	8.0	7.1	7.0	6.6

Table 3. Comparisons of means between males and females on participation motivation factors.

Factor	Males (n=387)	Females (n=410)	p
Achievement status (AS)	2.53 ± 0.77	2.21 ± 0.69	**
Sport goals (SG)	3.98 ± 0.69	3.70 ± 0.65	**
Team orientation (TO)	3.93 ± 0.88	3.85 ± 0.90	n.s.
Exertion (Ex)	3.27 ± 0.84	3.21 ± 0.76	n.s.
Fun (F)	3.61 ± 0.67	3.77 ± 0.74	**
Social influence (SI)	3.10 ± 0.71	2.98 ± 0.73	*

** ($p<0.01$), * ($p<0.05$), n.s. (not significant)

Arithmetic means of items which entered on each factor were used to derive overall scores on the respective dimensions of motivation for boys and girls. Results are summarized in Table 3. Boys have, on average, higher scores on three of the factors: F1, Achievement Status ($p \leq 0.01$); F2, Sport Goals ($p \leq 0.01$); and F6, Social Influence ($p < 0.05$). Girls have, on average, a higher score on F5, Fun ($p \leq 0.01$). Mean scores for F3, Team Orientation, and F4, Exertion, do not differ between boys and girls.

The top 10 (highest item mean scores) reasons for participating in sport for boys and girls are given in Table 4. Three of the top five items in boys comprise F2 (Sport Goals), while three of the top five items in girls comprise F5 (Fun).

Table 4. Top 10 reasons for participating in sports in males and females.

Boys (N=387)		Girls (N=410)	
24	I want to be physically fit	29	I like to have fun
29	I like to have fun	11	I like to meet new friends
6	I want to stay in shape	24	I want to be physically fit
15	I like to get exercise	2	I want to be with my friends
18	I like the team spirit	18	I like the team spirit
1	I want to improve my skills	15	I like to get exercise
8	I like the teamwork	6	I want to stay in shape
11	I like to meet new friends	8	I like the team work
23	I want to go to a higher level	12	I like to do something I'm good at
2	I want to be with my friends	1	I want to improve my skills

MOTIVATION FOR SPORT BY PARTICIPATION STATUS

Multivariate analyses showed significant differences among non-participants in organized sport (NP), those who discontinued participation in organized sport (FA), and those currently active in organized sport (A) within each sex (boys: $F=4.43$, $p \leq 0.01$; girls: $F=2.98$, $p \leq 0.01$). Subsequent univariate analyses indicated significant differences in five of the six factors among boys (Table 5). Except for F5 (Fun), boys currently active in organized sport score significantly higher on the factors than either non-participants or former participants.

Table 5. Univariate analyses of variance of the effect of sport participation status on participation motivation factors in males. Means and pairwise comparisons with adjusted alpha level. Legend: (NP) Never Participated; (FA) Former Athletes; (A) Athletes

	NP (n=120)	FA (n=120)	A (n=147)	F (df=2,383)	p	NP,FA	NP,A	FA,A
Achievement status (AS)	2.48	2.42	2.66	3.58	**			*
Sport goals (SG)	3.70	4.02	4.18	16.99	**	**	**	
Team orientation (TO)	3.68	3.93	4.13	8.89	**		**	
Exertion (Ex)	3.10	3.27	3.40	4.25	*		**	
Fun (F)	3.66	3.56	3.62	0.69	n.s.			
Social influence (SI)	2.98	3.06	3.23	4.56	**		**	

** ($p<0.01$), * ($p<0.05$), n.s. (not significant)

Results of univariate analyses among girls showed generally similar trends (Table 6). F3 (Team Orientation) does not differ among the three groups whereas the other five dimensions differ significantly. With one exception (F5, Fun), mean scores are highest in current organized sport participants and decrease systematically to former participants and non-participants.

Table 6. Univariate analyses of variance of the effect of sport participation status on participation motivation factors in females. Means and pairwise comparisons with adjusted alpha level. Legend: (NP) Never Participated; (FA) Former Athletes; (A) Athletes

	NP (n=235)	FA (n=138)	A (n=37)	F (df=2,406)	p	NP,FA	NP,A	FA,A
Achievement status (AS)	2.09	2.30	2.58	10.19	**	*	**	
Sport goals (SG)	3.63	3.72	4.07	7.67	**		**	**
Team orientation (TO)	3.82	3.85	3.99	0.51	n.s.			
Exertion (Ex)	3.13	3.26	3.52	4.73	**		**	
Fun (F)	3.70	3.90	3.82	3.31	*	*		
Social influence (SI)	2.89	3.07	3.28	4.63	**	*		

** ($p<0.01$), * ($p<0.05$), n.s. (not significant)

CANONICAL CORRELATIONS

Somatic Variables and Motives for Participating in Sports

The relationship between somatic variables and motives for participating in sports is significant for the first canonical correlate in boys [$r_{c1}=0.32$, $p<0.01$, extracted variance 6% and 36% for somatic and motivation variables, respectively]. Among girls, there are two significant canonical correlations [$r_{c1}=0.30$, $p<0.01$, extracted variance 9% and 12%; $r_{c2}=0.24$, $p<0.05$, extracted variance is 8% and 27%].

Among boys, the first pair of variates accounts for 61% of the overlapping variance. Boys having high levels of adiposity (0.49) are less motivated to exercise (see Figure 1). This lack of interest is especially evident in factors interpreted as social influence (-0.79), sport goals (-0.74), exertion (-0.64), achievement status (-0,53) and fun (-0,44).

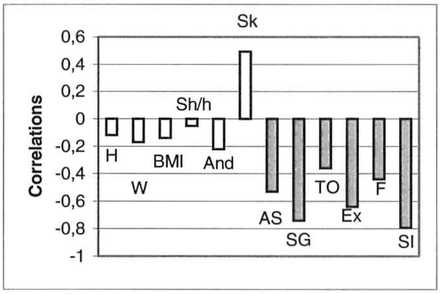

Figure 1. Correlations between somatic variables and motives for participating with the first pair of variates in males

Among girls, the first and second canonical correlations explained 70% of the overlapping variance. The first canonical correlate (Figure 2) results from bipolar combinations of variables on both sides of the equation. The second linear function (Figure 3) suggests that fatter girls are less motivated to participate in sports. Somatic variables load are positively correlated (sum of skinfolds, +0.72; body mass index, +0.67; body weight, +0.47) and motivation variables are negatively correlated (sport goals, -0.79; achievement status, -0.68; exertion, -0.59; social influence, -0.40) on the second variate.

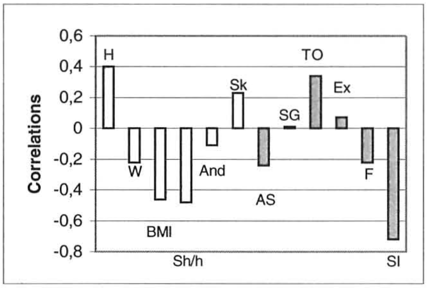

Figure 2. Correlations between somatic variables and motives for participating with the first pair of variates in females.

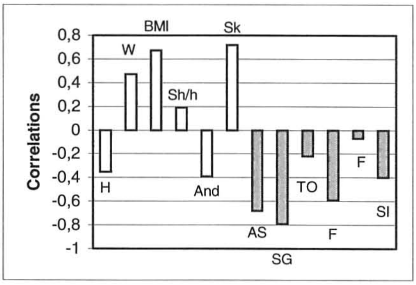

Figure 3. Correlations between somatic variables and motives for participating with the second pair of variates in females.

Motives for Participating in Sports and Social Stimulus

The canonical analysis of motives for participation in sport and social stimulus resulted in one significant canonical correlation for both boys [r_{c1}=0.20, p<0.05, extracted variance 26% for motives and 41% for social stimulus] and girls [r_{c1}=0.20, p<0.05, extracted variance 28% for motives and 33% for social stimulus], respectively. The first pair of variates accounts for 63% and 74% of the overlapping variance for males and females, respectively.

Among boys, social influence (+0.75) and material stimulus (+0.93) have the highest correlations with their variates (Figure 4). Therefore, boys receiving higher social incentives have a more positive attitude towards participation in sports.

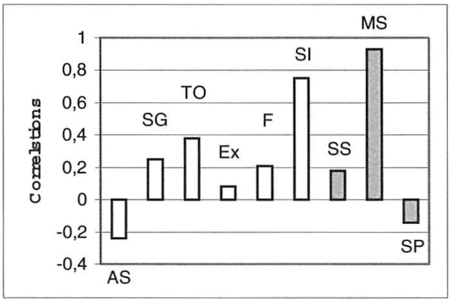

Figure 4. Correlations between motives for participating and social stimulus with the first pair of variates in males.

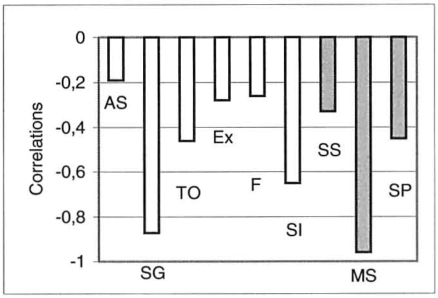

Figure 5. Correlations between motives for participating and social stimulus with the first pair of variates in females.

For girls, the canonical correlation expresses a direct association between lack of social incentives and motivation for participating (Figure 5). Girls having less incentives such as material stimulus (-0.96) and social participation (-0.45) show a poorer attitude towards sport participation, especially evident in the factors interpreted as sport goals (-0.87), social influence (-0.65) and team orientation (-0.46).

4. DISCUSSION AND CONCLUSIONS

FACTOR STRUCTURE OF MOTIVATION FOR SPORTS

Results of factor analysis of the 30 items of the motivation for sport questionnaire in the present sample of adolescents 15-18 years of age compare favorably with similar analyses of the responses of sports school participants 8-18 years in Iowa (Gill *et al.*, 1983), age group swimmers in Michigan (Gould *et al.*, 1985), and school children 10-15 years in Oporto (Serpa, 1992). In all studies, data for combined samples of males and females were analyzed in a similar statistical manner.

The factors extracted in each study are summarized in Table 7. With several exceptions, the extracted factors in each study are similar, although the present study obtained fewer components than the other studies. All extracted factors in the present study had Cronbach alpha coefficients >0.60. In the study of Oporto youth (Serpa, 1992), the factor labeled "Influence of family and friends" had an acceptable loading of only one item, while the dimensions labeled "Physical Fitness" and "Skill Development" had, respectively, acceptable loadings on only two items of the motivation for sport questionnaire. In the present study, F3 (Team Orientation) had acceptable loadings on only two items, whereas the other five extracted factors had acceptable loadings on three or more items of the questionnaire.

Table 7. Summary factors extracted from the 30-reason questionnaire of Gill *et al.* (1983) in different studies.

Study	Sample	Context	Factors	α-Cronbach
Gill *et al.*	n=1138	1979	Achievement/status	.76
(1983)	male, female	Iowa Summer School	Team	.78
	8-18 years		Fitness	.75
			Energy release	.65
			Situational factors	.49
			Skill development	.44
			Friendship	.30
			Fun	.55
Gould *et al.*	n=365	Michigan, Swimmers	Achievement/status	
(1985)	male, female		Team atmosphere	
	8-19 years		Excitement/challenge	
			Fitness	
			Energy release	
			Skill development	
			Friendship	
Serpa	n=175	Oporto	Achievement/status	.68
(1992)	male, female		Fun	.65
	10-15 years		Team orientation	.68
			Situational factors	.66
			Physical fitness	.61
			Skill development	.24
			Influence of family and friends	
Ávila	n=198	Azores	Sport affiliation	.83
And	male, female		Status	.76
Vasconcelos	12-18 years		Situational determinants	.65
Raposo			Emotional release	.67
(1999)			Achievement	.70
			Friendship	.48
Fonseca	n=1816	North, Portugal	Technical competence	
and	male, female		Physical fitness	
Maia	10-18 years	Handball, Track and,	General affiliation	
(2000)		field, basketball, soccer	Competition	
		gymnastics, swimming,	Team affiliation	
		Volleyball	Fun	
			Excitement	
			Status	
Present	797	Coimbra	Achievement/status	.81
Study	male, female		Sport goals	.78
	15-18 years		Team orientation	.70
			Exertion	.62
			Fun	.65
			Social influence	.66

EXCLUSION FROM SPORTS

The 30-item questionnaire reasonably differentiates adolescents who never participated in organized sport from former and current participants. Among boys and with the exception of the factor termed Fun (F), the data show a clear increase in item scores from non-participants (NP) to former participants (FA) to current participants (A). For girls and with the exception of the factor interpreted as team orientation (TO), mean scores also increased from non-participants to current participants to athletes. The results suggest that the motivation for sport questionnaire of Gil *et al.* (1983) might be a useful instrument in developing strategies for youth sports programs in communities with low levels of youth engaged in sport.

Adolescence is a period of great biological, psychological as well as social transformations. Each one of these domains should not be analyzed as a separate occurrence. Results of the canonical correlation analyses suggest that the development of motivation for participating in sports does not occur in a vacuum. Rather, relationships between social stimuli and participation motivation, and between physical characteristics (overall body size and fatness) and motives for participating in sports are indicated.

A major question of current interest, especially in public health, deals with the motivation for participating in physical activity, including sport, and/or for the discontinuation of participation among youth in general and among overweight and/or obese youth in particular. Sport is an important source of physical activity among youth so that motivations of overweight adolescents may provide some insights. For example, the motivation for participation in sports expressed by the leanest and fattest 10% (based on sum of skinfolds) of Portuguese boys suggest differences (Coelho e Silva *et al.*, 1999). The leanest boys scored significantly higher than the fattest boys in items related to winning, excitement, competition, advancement to higher levels of competition and physical fitness. Although not statistically significant, the fattest boys scored higher than the leanest boys on three out of 30 items on the questionnaire: "I want to get ride of energy", "I like the teamwork" and "I like being on a team".

In a similar study of urban Mexican youth, the motivation for sport and for discontinuing sports was compared in youth 14-18 years of age classified as normal weight (BMI>15th and <85th percentiles) and overweight (BMI≥85th percentile). The highest ranking motivations for participating in sport for normal weight boys and girls were having fun (1st), physical fitness (2nd), exercise (3rd boys, 4th girls), and getting rid of energy (4th boys, 3rd girls). Among overweight boys and girls, the order varied: physical fitness (1st), fun (2nd boys, 4th girls), exercise (3rd boys, 2nd girls) and to learn new skills (4th boys, 3rd girls). A subsample of boys and girls were also asked to rate the importance of reasons for stopping sport participation. The top three reasons for discontinuing participation in sport among overweight youth were the following: coach was a poor teacher (1st), too much emphasis on winning (2nd) and sport was no longer fun (3rd). Although differences between the fattest and leanest boys and between overweight and normal weight boys and girls are generally small, the trends suggest potentially important directions for future research. They indicate a need for more detailed study of the motivation for sport and physical activity in overweight/obese children and adolescents.

ELITE YOUNG ATHLETES

Elite young athletes are often a focus of discussion. Their motivation for sport is often assumed, but a question of potential interest is how they compare with the general adolescent population. To this end, data for the present sample are compared to youth athletes in several sports in Tables 8 and 9 for females and males, respectively.

Table 8. Primary reasons for participating in sport in several sports in studies of Portuguese females.

Reference	Grupo	Age, years	N	Top itens
Present study	School adolescents, Coimbra	16-18	410	I like to have fun I like to meet new friends I want to be physically fit I want to be with my friends I like the team spirit
Dju and Coelho e Silva, 2002	Basketball, Coimbra	13-16	96	I like the teamwork I like the team spirit I like to get exercise I want to improve my skills I like to have fun
Coelho e Silva, 2002	Basketball, 1st League	18-26	12	I like the teamwork I like the challenge I like the team spirit I want to be physically fit I want to go to a higher level
Massart *et al.*, 2001	Judo, National team	15-16	11	I want to improve my skills I like the teamwork I want to learn new skills I like to meet new friends I like to have fun
Sobral *et al.*, 2001	Line-skate runners, National team	16-19	6	I want to improve my skills I like the team spirit I want to be physically fit I like the teamwork I want to go to a higher level

Focusing on the 5 highest rate reasons for participation in sport, several trends of interest are apparent in both sexes:

- Reasons such as "I want to be with my friends" (item 2), "I want to stay in shape" (item 6), "I like to get exercise" (item 15) are specific to the general population of school adolescents;
- Reasons such as "I like to meet new friends" (item11), "I like the team spirit" (item 18), "I want to be physically fit" (item 24), "I like to have fun" (item 29) are shared by school adolescents, participants in sport, and top athletes;
- Reasons such as "I want to improve my skills" (item 1), "I like the teamwork" (item 8), "I want to learn new skills" (item 10), "I want to go to a higher level" (item 23) are shared by participants and top athletes;
- Reasons such as "I like to compete" (item 20), "I like the challenge" (item 26) are specific to top athletes;
- There does not appear to be a sex difference among elite athletes.

Table 9. Primary reasons for participating in sports in several studies of Portuguese males.

Reference	Grupo	Age, years	N	Top itens
Present study	School adolescents, Coimbra	16-18	387	I want to be physically fit I like to have fun I want to stay in shape I like to get exercise I like the team spirit
Ferreira and Coelho e Silva, 2002	Basketball, Coimbra	13-16	110	I want to improve my skills I like the teamwork I want to go to a higher level I want to be physically fit I like the team spirit
Figueiredo *et al.*, 2002	Soccer, Coimbra	11-16	95	I like the teamwork I want to be physically fit I want to go to a higher level I like the team spirit I want to learn new skills
Santos and Coelho e Silva, 2002	Basketball, national team	15-16	16	I want to improve my skills I like the teamwork I like the team spirit I want to be physically fit I want to learn new skills
Massart *et al.*, 2001	Judo, national team	15-16	34	I like to compete I want to go to a higher level I want to be physically fit I want to improve my skills I want to be with my friends
Sobral *et al.*, 2001	Line-skate runners, national team	16-19	10	I want to go to a higher level I want to be physically fit I want to improve my skills I like the team spirit I want to learn new skills

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ORGANIZED SPORT AMONG URBAN MEXICAN YOUTH

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1. INTRODUCTION

Although the structure of youth sport programs varies among countries (De Knop *et al.*, 1996), it is reasonably well established that significant numbers of children and adolescents throughout the world are involved in organized sport. Organized youth sport implies the presence of a coach, and regular practices and competitions during the course of a season. Sport offerings vary with cultural context, and it is generally assumed that European football (soccer) is the most popular youth sport in the world. In addition to organized sports, youth throughout the world participate in informal sport activities on a regular basis.

Many children begin participating in sport during childhood, often by 6 or 7 years of age, and participation rates increase with age during childhood. Rates subsequently decline during the transition into adolescence, i.e., after about 12-13 years of age, and through adolescence. The decline in youth sports participation after 12-13 years parallels declining rates of participation in physical activities in general across adolescence (Malina, 1995).

Given the age-related pattern of participation in organized sport, questions related to the motives of children and adolescents to participate, to discontinue participation and to return to participation often surface in the sport-related literature. This study considers motivation for sport in urban Mexican youth 9-18 years of age.

2. METHODS

A survey of the growth status, physical activity and sport participation of approximately 1100 urban Mexican school youth 9-18 years of age was conducted in 1998. A subsample of 591 youth completed questionnaires dealing with sport participation. This sample comprises the basis for this report.

The structure of the school system in Mexico includes the primaria (grades 1-6, approximately 6-12 years), secundaria (middle school with three grades, approximately 13-15 years of age), and preparatoria (high school with three grades, approximately 15-18 years of age). Compulsory schooling requires that children attend until they are 16 years of age; hence. many do not complete high school. The sample was derived from the upper grades of the primaria (grades 4, 5 and 6) and from secundaria and preparatoria in zones of the Federal District that could be classified as low, middle and upper socioeconomic status (SES).

The sample included 292 boys, among whom 168 (58%) were involved in an organized sport at the time of the survey, and 299 girls, among whom 109 (36%) were involved in an organized sport at the time of the survey. Sixteen boys and 22 girls were previously active in organized sport but were no longer active. As noted earlier, an organized sport implied the presence of a coach, and regular practices and competitions during the course of a season.

Four questionnaires, all in Spanish, were used. The first instrument was administered to the total sample of 591 students. It included basic demographic information, current sport participation status, level of physical activity, television and video game habits, perceived level of physical fitness, and perceived level of physical activity relative to peers. The three other instruments were Spanish translations of questionnaires used in a national survey of American youth 10-18 years of age in the mid-1980s (Ewing and Seefeldt, 1988). The questionnaires were field tested and modified as needed, albeit slightly, to fit the cultural context of Mexico.

A questionnaire related to reasons for participating in sport was administered to those who were currently (168 males, 109 females) or previously (16 males, 22 females) active in an organized sport (totals: 184 males, 131 females). It asked the youth 9-18 years of age to rate on a five-point scale 26 items related to reasons for participating in sport.

A questionnaire related to reasons for discontinuation of participation in sport was administered to high school youth 14-18 years of age who were no longer active in organized sport (71 males, 88 females). It asked the youth to rate on a five-point scale 42 items related to why they discontinued participation in organized sports.

A questionnaire related to reasons for returning to sport participation was also administered to high school youth 14-18 years of age who were no longer active in sport (66 males, 83 females). It asked the youth to rate on a five-point scale 22 items in response to the statement: " I would return to sport if..."

3. RESULTS

Sport Preferences

The sports indicated by the youth are summarized in Table 1. The preferred sport for boys was European football (soccer), followed by basketball, swimming, American football and baseball. The preferred sport for girls was basketball, followed by swimming, gymnastics, skating and volleyball.

Table 1. Organized sports reported by urban Mexican youth 9-18 years of age who were active in sport at the time of the survey. Percentages do not add to 100% because many youth participated in more than one sport.

Boys			Girls		
	N	%		n	%
1. Football (soccer)	128	76	1. Basketball	70	64
2. Basketball	97	58	2. Swimming	61	56
3. Swimming	80	48	3. Gymnastics	47	43
4. Football (American)	57	34	4. Skating[1]	47	43
5. Baseball	49	29	5. Volleyball	47	43
6. Skating[1]	47	28	6. Tennis	28	26
7. Tennis	39	23	7. Football (soccer)	27	25
8. Volleyball	37	22	8. Athletics	20	18
9. Bowling	28	17	9. Bowling	18	17
10. Athletics	26	15	10. Baseball (softball)	17	16
11. Gymnastics	24	14	11. Football (American)	17	16
12. Wrestling	15	9	12. Wrestling	9	8
13. Others[2]	44	26	13. Others[2]	36	33

[1]In-line and roller skating. [2]Other sports included martial arts, squash and racquetball among boys and dance and martial arts among girls.

Age variation was suggested in several sports. Among boys 9-13 years, soccer was the preferred sport for 83% (66 of 80), whereas among boys 14-18 years, soccer was the preferred sport for 70% (71 of 87). Soccer was followed in popularity by basketball, swimming and skating among the younger boys, while it was followed in popularity by swimming, basketball and American football among older boys. Among girls 9-13 years (n=46), approximately equal numbers participated in skating (34, 74%), swimming (31, 67%) and basketball (30, 65%), followed by a slightly smaller number in volleyball (27, 59%). Among girls 14-18 years (n=63), on the other hand, the majority participated in basketball (40, 63%), followed by swimming (30, 48%), skating (26, 41%) and gymnastics (24, 28%).

Variation in sport by SES was also suggested. Soccer was the most common sport among low and middle SES boys, but ranked third among high SES boys, among whom swimming was the most popular sport. Basketball was second in popularity among boys in the three SES categories. Interestingly, baseball, which has a long tradition in Mexico (there is an active professional league), ranked fourth among low SES boys and sixth among middle and high SES boys. American football, on the other hand, ranked higher than baseball among middle and high SES boys.

In contrast to boys, there was very little SES variation among girls. Basketball was ranked first among girls in the three SES categories. Basketball was followed by skating, swimming and gymnastics among low and middle SES girls; volleyball replaced gymnastics among high SES girls.

Sport Participants and Non-Participants

Sport participants and non-participants were compared in several questions related to physical activity, physical fitness and physical inactivity (television, video games). Comparisons were made with ANCOVA with age as the covariate. Sport participants of both sexes were significantly younger ($p<0.05$) and more physically active ($p<0.05$) than non-participants. Sport participants also perceived themselves as having a better level of physical fitness ($p<0.05$) and a higher level of physical activity compared to their peers ($p<0.05$ in females, $p=0.06$ in males). On the other hand, participants and non-participants in sport did not differ significantly in reported time watching television and playing video games.

Motivation for Sport

The ten highest ranked reasons for participating in sport are summarized in Table 2. The motives are remarkably similar between boys and girls. Fun is the primary motivation for participating in sport. Motives that follow fun focus on physical fitness, exercise, getting rid of excess energy and skill development. These highlight the role of sport in meeting the physical activity and health- and performance-related fitness needs of youth.

Competition-related motives appear among the top ten motives for participating in sport in boys (items 8-10 in Table 2) compared to girls (item 7). It is of interest that winning does not appear among the ten highest ranked motives for participating in sport. Winning ranked 13th and 14th among reasons for participating in sport in boys and girls, respectively.

Table 2. Ten most important reasons for participating in organized sports among urban Mexican school children 9-18 years of age.

Boys		Girls	
1.	To have fun	1.	To have fun
2.	To be physically fit	2.	To be physically fit
3.	To get exercise	3.	To get exercise
4.	To get rid of energy	4.	To get rid of energy
5.	To improve my skills	5.	To improve my skills
6.	To do something at which I am good	6.	To do something at which I am good
7.	To learn new skills	7.	For the excitement of competition
8.	For the excitement of competition	8.	To learn new skills
9.	For the challenge of competition	9.	To have something to do
10.	To get to a higher level of competition	10.	To be with my friends

An exploratory factor analysis was conducted to evaluate the clustering of motives for participation in sport. Four clusters of motives (factors) accounted for about 43% of the variance in the sample. Nine items loaded on a factor that was labeled as recognition or external awards and accounted for 17% of the variance. Four items loaded on a factor that could be labeled as physical fitness and accounted for 12% of the variance. The three competition items formed a cluster labeled as a competition factor and accounted for 9% of the variance. Three items, including the fun item, clustered to form an outside activity factor and accounted for an additional 5% of the variance. Overall, factor scores differed significantly between boys and girls ($p \leq 0.001$), and subsequent univariate F-tests indicated significant sex differences in the three factors. Girls scored significantly higher on the factor related to recognition or external awards ($p \leq 0.001$), while boys scored significantly higher on the factors related to competition ($p \leq 0.001$) and outside activity ($p \leq 0.05$).

Motives for Discontinuing Sport

As noted earlier, this questionnaire was administered only to high school students 14-18 years of age. The ten highest ranked reasons for discontinuing participation in sport are summarized in Table 3. Although the order of the top ten motives differs slightly between boys and girls, the choices themselves are quite similar. The first three reasons for discontinuing participation in sport in both boys and girls relate to time – time for study, time demands of the sport, and time conflicts. Both boys and girls note the potentially negative influence of pressure related to sport and the ability or role the coach as a teacher. Girls also indicate two other coach-related potentially negative influences, favoritism and lack of playing time.

Table 3. Ten most important reasons for discontinuing participation in sport among urban Mexican youth 14-18 years of age

Boys		Girls	
1.	The games and practices were scheduled at times when I could not attend	1.	I needed more time to study
2.	I needed more time to study	2.	The sport required too much time
3.	The sport required too much time	3.	The games and practices were scheduled at times when I could not attend
4.	Too much emphasis on winning	4.	I could not afford to play and practice year round
5.	I was not having fun	5.	There was too much pressure
6.	There was too much pressure	6.	My coach was a poor teacher
7.	My coach was a poor teacher	7.	I did not have the opportunity to play much
8.	I could not afford to play and practice year round	8.	I wanted to participate in other non-sport activities
9.	I was no longer interested in the sport	9.	I was no longer interested in the sport
10.	I wanted to participate in other non-sport activities	10.	The coach played only his/her favorite players

Table 4. Ten most highly ranked responses to the statement: "I would return to sport if…." in urban Mexican youth 14-18 years of age.

Boys		Girls	
1.	The practices or games did not conflict with my studies	1.	The practices or games did not conflict with my studies
2.	The games and practices were scheduled at other times	2.	The games and practices were scheduled at other times
3.	I could play more	3.	The practices or games did not interfere with my social life
4.	The games or practices did not interfere with my social life	4.	The sport did not demand so much time
5.	The sport did not demand so much time	5.	I could play more
6.	The practices were more fun	6.	There were more or closer practice facilities
7.	There were more or closer practice facilities	7.	The coach was a better instructor
8.	There were more leagues so the other players were closer to my ability level	8.	The coaches understood the players better
9.	The coaches understood the players better	9.	The practices were more fun
10.	The coach was a better instructor	10.	There were more leagues so the other players were closer to my ability level

Both boys and girls also note the role of changing interests and desire to participate in non-sport activities as factors influencing the decision to discontinue participation in sport. This highlights normal changes in adolescent behaviors and interests which are unrelated to sport.

Returning to Sport

Changes in sport that would be conducive to attracting youth to return to participation in organized sport are summarized in Table 4. As in motives for participation and discontinuing participation, responses to the statement, "I would return to sport if...," are remarkably similar in boys and girls. Four of the five highest ranked reasons relate to time and social life in both sexes – time for study, time conflicts, time demands, and interference with social life. The fifth item (ranked 3rd in boys and 5th in girls) relates to playing time, a factor controlled by coaches. Three of the items ranked between 6th and 10th relate primarily to coaches – teaching ability, practices and understanding of players. The final two items relate to sport or league administration – proximity of practice facilities and ability level of players.

4. DISCUSSION

The results of the survey of Mexican youth, though limited in numbers to school youth in the Federal District (Mexico City), need to be viewed in the context of sport preferences and sport availability in different countries. Mexico, for example, does not have highly developed high school sport programs as in the United States. Moreover, organized sport programs are more readily available in the larger urban centers in contrast to rural areas of the country. In this survey of urban Mexican youth, the five most popular sports for boys, in order of preference, were soccer, basketball, swimming, American football and baseball. The five most popular sport activities for urban Mexican girls, in order of preference, were basketball, swimming, gymnastics, volleyball and skating. Skating (in-line or roller skating) is most often a recreational sport, although competitive skating programs are increasing in number. There was, however, variation with age in the Mexican sample. Soccer was the highest ranking sport for boys across all ages. Among boys 9-13 years of age, soccer was followed by basketball, swimming, skating and baseball; among boys 14-18 years, soccer was followed by swimming basketball, American football and baseball. Skating was the most popular sport activity for Mexican girls 9-13 years, whereas basketball was the popular sport in girls 14-18 years.

The most popular organized sports for American youth 6-17 years of age, based on numbers of participants in 2000, were as follows: boys – baseball, basketball, soccer, American football, athletics; girls – soccer, basketball, softball, volleyball, cheerleading (Sporting Goods Manufacturers Association, 2001). The statistics include community- and school-based sports with regularly scheduled games. If the estimates are combined for boys and girls, soccer is now the second most popular sport among American youth. The numbers are estimates and some youth participate in more than one sport. For example, among organized sport participants 6-17 years of age in the United States, 44% played one sport, 30% played two sports, 17% played three sports, and 9% played four or more sports (Sporting Goods Manufacturers Association, 2001).

Table 5. Ten most important reasons for participating in organized sports among Mexican boys 9-18 years of age and American boys 10-18 years of age.

Mexican Boys		American Boys[1]	
1.	To have fun	1.	To have fun
2.	To be physically fit	2.	To do something I am good at
3.	To get exercise	3.	To improve my skills
4.	To get rid of energy	4.	For the excitement of competition
5.	To improve my skills	5.	To stay in shape
6.	To do something at which I am good	6.	For the challenge of competition
7.	To learn new skills	7.	To get exercise
8.	For the excitement of competition	8.	To learn new skills
9.	For the challenge of competition	9.	To play as a part of a team
10.	To get to a higher level of competition	10.	To go to a higher level of competition

[1]Adapted from Ewing and Seefeldt (1988).

Table 6. Ten most important reasons for participating in sport among Mexican girls 9-18 years of age and American girls 10-18 years of age

Mexican Girls		American Girls[1]	
1.	To have fun	1.	To have fun
2.	To be physically fit	2.	To stay in shape
3.	To get exercise	3.	To get exercise
4.	To get rid of energy	4.	To improve my skills
5.	To improve my skills	5.	To do something I am good at
6.	To do something at which I am good	6.	To learn new skills
7.	For the excitement of competition	7.	For the excitement of competition
8.	To learn new skills	8.	To play as a part of a team
9.	To have something to do	9.	To make new friends
10.	To be with my friends	10.	For the challenge of competition

[1]Adapted from Ewing and Seefeldt (1988)

More specific estimates for high school sports in the 1999-2000 school year indicated about 3.9 million (26%) boys and 2.7 million (18%) girls in grades 9-12 (approximately 14-18 years of age) who participated on interschool sport teams. The five most popular high school sports based on numbers of participants in 1999-2000 are as follows: boys - American football, basketball, athletics, baseball, soccer; girls - basketball, athletics, volleyball, softball, soccer. The number of male and female participants in high school soccer in the United States increased dramatically from 1989-1990 to 1999-2000, by approximately 50% in boys and 142% in girls (Malina, in press).

The structure of competitive sport programs in Mexico and the United States is different. Many sport programs are centered in clubs in contrast to community and municipal entities, although the number of interschool sport offerings in Mexico, especially in larger urban centers, is increasing. In addition to local cultural influences, the structure of the programs, of course, may influence the sports available to youth

The reasons why children and adolescents of both sexes participate in sport included the following: to have fun, to improve skills and to learn new skills, to be with friends or to make new friends, for thrills and excitement, to get physical activity (exercise), and to become physically fit, among others. With few exceptions, the reasons stated by Mexican youth 9-18 years of age for participation in sport are quite similar to those stated by American youth 10-18 years of age (Tables 5 and 6). The data for American youth were from a national sample surveyed in the late 1980s (Ewing and Seefeldt, 1989), whereas those for Mexican youth were collected in 1998. Fun (enjoyment), skill learning and socialization are central to the why children participate in sport.

Table 7. Ten most important reasons for discontinuing participation in sport among Mexican boys 14-18 years of age and American boys 10-18 years of age.

Mexican Boys		American Boys[1]	
1.	The games and practices were scheduled at times when I could not attend	1.	I was no longer interested in the sport
2.	I needed more time to study	2.	I was not having fun
3.	The sport required too much time	3.	The sport required too much time
4.	Too much emphasis on winning	4.	The coach played favorites
5.	I was not having fun	5.	The coach was a poor teacher
6.	There was too much pressure	6.	I was tired of playing
7.	My coach was a poor teacher	7.	Too much emphasis on winning
8.	I could not afford to play and practice year round	8.	I wanted to participate in other non-sport activities
9.	I was no longer interested in the sport	9.	I needed more time to study
10.	I wanted to participate in other non-sport activities	10.	There was too much pressure

[1]Adapted from Ewing and Seefeldt (1988).

Reasons for discontinuing participation in sport stated by Mexican and American youth are summarized in Tables 7 and 8. Changing interests, lack of fun or enjoyment in sport, and several coach-related behaviors are associated with discontinuation of sport " in American youth of both sexes. Changing interests and attempts at new and different activities are related to normal behavioral development as youth enter and progress through adolescence. In contrast to American youth, time commitment to sport is a major concern associated with discontinuation of sport among urban Mexican youth. Mexican youth rank the time commitment for study more highly, i.e., sport participation takes up too much time and it may reduce time available for study. However, females rank the need for more time to study more highly than males. Coaching concerns, pressure to win and lack of interest also surface as reasons for discontinuing sport among Mexican youth.

Table 8. Ten most important reasons for discontinuing participation in sport among Mexican girls 14-18 years of age and American girls 10-18 years of age

Mexican Girls		American Girls[1]	
1.	I needed more time to study	1.	I was no longer interested in the sport
2.	The sport required too much time	2.	I was not having fun
3.	The games and practices were scheduled at times when I could not attend	3.	I needed more time to study
4.	I could not afford to play and practice year round	4.	There was too much pressure
5.	There was too much pressure	5.	The coach was a poor teacher
6.	My coach was a poor teacher	6.	I wanted to participate in other non-sport activities
7.	I did not have the opportunity to play much	7.	The sport required too much time
8.	I wanted to participate in other non-sport activities	8.	The coach played favorites
9.	I was no longer interested in the sport	9.	I was tired of playing
10.	The coach played only his/her favorite players	10.	Games and practices were scheduled at times when I could not attend

[1]Adapted from Ewing and Seefeldt (1988).

Presently available data on motivation for participation in sport and for discontinuation of sport are general, do not consider specific sports, and do not account for changes in descriptive terms with age. Cultural variation is an additional factor. For example, the meaning of "what is fun in sports" probably differs with age and perhaps among specific sports and type of sport program (community-based, recreational, club, interscholastic). Systematic data are not extensive for specific factors indicated as related to discontinuation in a sport. Important considerations include, among others, type of program, structure of the sport organization, level of competition, intensity of training and competition, individual differences in growth, maturation and development, status of the individual on a team or club, and cultural variation in adolescent time and school demands. An important role for coach behaviors and quality of coaching in motivation to continue or discontinue in a sport is indicated.

In the total sample of Mexican youth (n=591), sport participants reported higher levels of overall physical activity compared to non-sport participants. This is consistent with observations of American youth active and non-active in organized sports. Youth active in sport expended more energy in physical activity than those who were not active in sport (Katzmarzyk and Malina, 1998). The American study differed from the Mexican data in that American youth active in sport also spent less time viewing television, i.e., being inactive, whereas sport participants and non-participants in the Mexican survey did not differ in reported time viewing television and playing video games.

There is also the possibility that those with a history of participation in youth sports may more physically active as adults, but data to this effect are limited (Engstrom, 1986, 1991; Kuh and Cooper, 1992; see also Malina, 2001). Instruction and practice associated with sports programs contribute to development and refinement of a variety of sport specific motor skills, which provide the foundation for other skills and for an active life style. However, children should be given a voice or a choice in their sport participation. Being forced to exercise during childhood may have potentially negative consequences for later activity (Taylor *et al.*, 1999).

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THE IMPORTANCE OF VALUES IN THE COACHING PROCESS

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1. INTRODUCTION

The subject of this paper is values in coaching and their role in the coaching process; I will address most of my remarks specifically to the coaching of children. My purpose is to encourage coaches to develop a personal philosophy of coaching that emphasises the well-being of the children under their care. Children are vulnerable to a variety of adult influences and sport provides many opportunities for them to be exploited to meet the needs of other people, even to the extent of child abuse (see for example, Ryan, 1995). For children to get the most out of the sporting experience coaches need to consider carefully how they can best serve primarily the needs of the children while at the same time meeting their own needs and those of the sport and clubs which they represent. Naturally there is a potential for considerable conflict here since the young athletes, coaches, clubs, sport governing bodies, and parents may all have differing ideas about the purposes of sport and the desirability of specific practices.

You may have asked yourselves why we provide sport for children. If so, you have probably also asked why you are part of the process. These questions are very important because coaching children is a great responsibility. Coaches have a great impact not only on how children experience sport but also because children's attitudes, toward both themselves and the world, are not fixed but still forming, and coaches have an effect on their development.

Knowing clearly what part you are going to play in providing sport experiences for children is a matter of having a personal philosophy, a set of values which guides the things you do to present the sport to the children you coach. You need to be aware of what it is that you are really trying to do, and that it fits what the children need and want.

Patterns of growth and participation in youth sport

Population changes and participation patterns among children affect how sports federations promote their own sports and retain the interest of young people. They also raise questions about the role that sport plays in children's lives and who are the main beneficiaries of youth sport programmes.

Sports federations sometimes worry that children drop out of sport during their teenage years, often when they are between 14 and 16 years old. Surveys have shown that the number of teenagers who do sport regularly decreases with age. The reasons for their dropping out may be many but perhaps we should ask whether it is necessarily a "bad thing". Some research shows that children drop out of some activities so that they can spend more time on other activities – including other sports, the demands of school work, lack of the pleasure that the sport gives them, and lack of success, (see Brustad, 1993; Whitehead, 1993).

Dropping out of sport may matter because it stops the development of a pattern of activity that may benefit peoples' health throughout their lives. Some coaches and administrators think that it is always a bad thing for children to drop out of sport - or even to move on to a better team. But it may be the best thing for the children and their progress in life if they have something better to do. Nevertheless, the sporting experience may have still provided valuable self-knowledge and personal satisfaction.

Certainly, at least in the UK, it is plausible to conclude that while children take up sport in late childhood many drop out during mid-adolescence. It may not be coincidental that this period is associated with increased pressure to succeed in public academic examinations. Indeed children my be placed in a position where they must consider the relative benefits of trying to succeed in both their studies and sport and be forced to emphasise one at the expense of the other. Further, as young athletes become more proficient they experience a need to specialise in fewer sports than they began. Hence, many of those who drop out of one will continue to participate in others (Tasmanian State School Sports Council, 1983).

Aims of youth sport provision

Children's reasons for doing sport may be different from those of the providers – governments, federations, clubs, coaches, parents etc. Each of these groups has its own goals that may not take account of what is most important or what is most beneficial to children. For them, having fun, learning new skills, and being with friends as well as competition are among the most important things (see Weiss, 1993). They do not necessarily do it to win medals or develop social skills, although these things may come out it. To work successfully with children coaches need to keep this in mind; then their players will keep coming back and they can advance their skills and help them to become better performers. Sport, as adults know it, is not part of their world until we make it so. For children, if the fun stops there is little point in being there!

2. SPORT IN MODERN SOCIETY

It is important to distinguish between the value of sport to a society and the values that exist within a sporting culture. Rokeach (1973) made an important clarification of the term 'value' in a seminal discussion of the concept. He drew attention to the different ways in which the word value was used first to express the value that an object is said to have and second to express the value that an individual is said to hold or adhere to. So, for example, a footballer may be of particular value to his team as a striker and be worth several million euros. But that footballer may hold values to do with winning, or achievement, or with honesty, team spirit, and playing by the rules. These are motivating forces that determine how he will play the game. In the former sense, sport may be of value to a society by providing certain good things to it, much as our striker provides goals. These values may be thought of as functions, although they are not the explicit reasons for doing sport

In this sense, sport provides a wide range of functions in contemporary society. The values of sport have been widely considered by sports philosophers and sociologists who have variously considered that sport provides opportunities for élitism, nationalism, economic growth and education to name but a few (see for example Tannsjo and Tamburrini, 2000; Glassford, 1989).

Elitism: In Western capitalist democracies, societies reward achievement through skill and hard work. Those who do not succeed are frequently disadvantaged. In sport, this may be reflected in a philosophy of retaining only those who are winners, the others are discarded. In a recent argument, Tannsjo (2000) suggested that sport encourages the fascist values of admiration of strength and contempt for weakness. He believes that this is particularly true of individual sports, such as those that take pride of place in the Olympic Games, where spectators can be overwhelmed by demonstrations of superiority. While the fascist conclusion may be challenged, there remains the problem of the admiration of the élite by fans leading to a decline in participation as viewing excellence becomes more readily available to spectators. This has recently been exemplified in the UK by the loss of television revenue due to low viewing numbers for lesser football leagues; this has resulted in the loss of jobs for players and threats to the existence of clubs. The pursuit of élitism, which increasingly drives sport as a business, even suggests that advances in gene therapy might eventually result in the production of athletes to order (Bouchard, 1999; Munthe, 2000).

Nationalism: Allied to the pursuit of superiority is the role of sport in the promotion of national identity and esteem. We have become accustomed to the display of national fervour at international sporting events. The idea that sport provides an acceptable way to display international rivalries, even hostilities, has become commonplace (Chataway and Goodhart, 1968; Dixon, 2000). Morgan (2000) has suggested that this is even more potent where sport provides the means for underprivileged nations to establish their identity and independence from former colonists. The power of World Cups and Olympic Games is such that citizens may feel good or bad according to how their representatives perform sometimes with tragic effects. In some cases, such as East Germany prior to 1989, young athletes may be subjected to controlled drug programmes designed to enhance their performance in the interests of the state (Franke and Berendonk, 1997).

Commercialism: In a similar way children provide the raw material for the progress of the sport industry. Sport is now a major part of the leisure and entertainment business with global companies in the form of sports, such as Formula One, or of clubs, such as Manchester United, being marketed like any other commercial product. In order to survive sports and clubs must be able to demonstrate and sustain excellence. In the United Kingdom (UK), sport provides over 400,000 full time jobs and another 108,000 full-time equivalent jobs among volunteers. The value added to the UK economy in 1995 was £9.8 billion, twice the value in 1985 and sponsorship was estimated at £404 million in 2000 (Sport England, 2002). An industry of this magnitude requires both the effective selection of raw material and product development to sustain it. Consequently those who cannot meet the standards required are rejected and young people who cannot make the grade may be discouraged to the point of giving up altogether. In this sense children are the raw material, once again, and the search for talented athletes who can be identified and signed up early becomes ever more intense.

Talent identification: Coaches have an important role in the process of the identification and development of potentially élite performers for commercial and nationalistic purposes. While the value, or importance, of sport in these fields is undeniable and laudable, the process puts coaches in the delicate position of balancing the needs of companies or governments with the individual needs of children. The 18th century philosopher, Immanuel Kant, proposed a number of imperatives about human behaviour, one of which is that no person should be the means to another's ends. In other words, it is morally wrong to exploit others for our own purposes. And yet, in the world of sport, this is increasingly difficult to avoid. Sport becomes a saucepan for cooking young people in a variety of ways to produce entertaining dishes!

Education: There are, of course, positive benefits to children, whether they become members of the élite or not. Many people have believed for a long time that, through sport, children can learn new physical and social skills, develop self-confidence, and meet challenges (see Shields and Bredemeier, 1995). It also allows them to prepare for adult recreation patterns that may last throughout their lives. This can have the effect of promoting a healthy population – and reduce costs to government health care programmes. This may be increasingly important as western society makes greater attempts to counter the spread of obesity.

Successful sports performers add status to their clubs, sports federations and governments, and can be important sources of income for them. All of this is seductive to those who promote sport for young people – they can claim altruistic motives. However, those who are charged with coaching young people must make choices about the relative importance of their values in relation to their coaching duties and decide what the important outcomes should be.

3. SPORTING VALUES

In light of these arguments, coaches are faced with a number of dilemmas when they begin coaching children. Some of them are summarised in Table 1:

Let us look briefly at these dilemmas. The conflict between élitist and populist goals suggests two different approaches to coaching sessions and selection. The elitist position, for example, would give preference to the best performers, while the populist would ensure that all children got equal treatment, playing time, training opportunities etc. The nationalist position is to promote and develop success in one's own nation, region, club, or school at the expense of others. It has become the norm for nations to put considerable resources into junior sports programmes in order to achieve success in the international arena. However, many international governing bodies recognise that in order to promote their sport the strong must support the weak; so we see programmes of international development to nations with fewer resources or little history in the particular sport. The current strategy of the International Rugby Board is a case in point. A strong competitive programme is essential for the growth and survival of any sport; competition for audiences lies between sports rather than within them.

The promotion of nationalist objectives, however, seems increasingly to drive government policies in sport. We might suggest that nationalism is akin to commercialism in promoting a particular product and is concerned with the élite performer. But most youth sport coaches deal primarily with those children who have no national expectations or commercial value. Their athletes will strive to become as good as they can, to have fun, to meet a challenge, and to be with friends (see Brustad, 1993 for review). Perhaps most coaches, therefore, should be concerned with helping them meet those goals.

Table 1: Dilemmas facing coaches

Goals	Élitist	Vs	Populist
	Nationalist	Vs	Universalist
	Commercial	Vs	Charitable
	Education	Vs	Performance
	Personal achievement	Vs.	Superiority over others
	Fairplay	Vs	Winning
Needs	Child	Vs.	Coach
	Child	Vs	Club
	Child	Vs.	Sport
	Child	Vs	National / sponsor's interest
Values	Benevolence	Vs.	Power / Status

The key seems to lie in making the choice between *Education* and *Performance*. This dilemma forces decisions about whether it is more important to emphasise goals concerned with getting better or goals concerned with being the best. So, is it more important to be fair or to win? Is it more important to concentrate on becoming more skilful or to win? Is it more important to promote the development of the child or the development of the sport, club, or nation? The answers to these questions reflect the primacy given to the needs of the children we coach or to various sport providers and sponsors. But it should not be concluded that these answers are, necessarily, mutually exclusive. Essentially, the dilemmas that coaches have to face are resolved by their value systems because, in the end, all our choices are defined by our values. Coaches who place the welfare of others above personal power and status will choose to develop children's performance. Coaches who think that power, prestige, and status are more important will choose to win above all. Nevertheless, these distinctions are not made easily. Such has been the expansion of sport as a form of business and entertainment during the relatively recent past that for those youngsters who succeed the future is often assured. However, for all those who succeed, many fail, in relative terms. A former director of the German Sports Institute in Leipzig once said that they worked on ratio of 100–1. To identify and develop one champion they needed to start from a base of 100 (Dietrich, 1998, personal communication).

Turning to the questions of whose needs are met, you will see that I suggest that there are conflicts between the needs of the child and the coach, club, sport, nation or sponsor. Children are particularly vulnerable to the influence of others and susceptible to manipulation by social forces of which they are unaware. Yet, their needs must be paramount if we are to adhere to

Kant's moral imperative and not use children to satisfy our own ambitions. The decisions may be very sensitive when dealing with talented children. How can you help them to develop those talents to the maximum while at the same time not threatening their futures should they eventually fail in their chosen sport either through lack of ability or circumstance, such as injury?

This leads us to the final category of values in which benevolence is contrasted with power and status. Schwartz (1992) has developed a model of values based upon two basic motivational dimensions: *Openness to Change* to *Stability* and *Self-interest* to *Concern for Others*. The model locates different value dimensions about the axes such that domains, groups of values that are compatible with each other are adjacent and those that conflict with each other are opposite to each other. The model draws attention, therefore, to the difficulty in reconciling conflicting values. In this case, benevolence, which shows a concern for others, conflicts with the pursuit of power and status, which exemplify self-interested values.

In discussing his model Schwartz (1992) points out that it is possible for apparently conflicting values to be held within the same belief system because conflicts only arise infrequently in everyday life. However, I would suggest that conflicts of value arise commonly in sport. Schwartz' (1992) model indicates that the pursuit of success is entirely compatible with the pursuit of pleasure and with the pursuit of power, status and prestige, which are located in adjacent areas. They are set against the more altruistic value domains that identify the welfare of others as paramount. Yet, we like to think that sport provides a good environment for the development of altruism, fairplay, sportsmanship and so on. However, we cannot ignore the fact that sport, by its very nature is self-interested – the purpose is to demonstrate superiority, power over others, and the status that is associated with success. At the same time, it is conducted according to an agreed set of rules to which all competitors are expected to perform. Nevertheless, élite sport seems increasingly to demand that altruistic values are set aside in favour of self-interested values, and the search for potential élite performers leads to a culture in which the weak go to the wall.

We do not know a great deal about the values of the majority of coaches who work with children but we do have some information from adolescent athletes. They think that the most important things in sport are enjoyment, showing achievement by getting better, and playing fairly. They do not appear to think that winning is as important (Mielke and Balke, 1995; Lee *et al.*, 2000). They also think that the most important people who influence their thinking are their coaches (Lee and Balchin, 1996). This suggests that those coaches transmit values that show their concern for others.

4. PROVIDING GOOD COACHING

Knowing your values

So, how can we do the best job for young athletes? Most importantly coaches should be clear about their values; they must decide what is most important to them in coaching children. Placing the children's needs first does not mean that sport need be simply an extension of unstructured play. It means providing an environment in which children can realise their potential and learn more about themselves as human beings. In short, helping them to grow up. If we help that process we may also be able to help them become great athletes. But remember - if winning is the only important thing in the coach's mind and in the children's minds then when they lose there is nothing left! Winning is not entirely in the control of either coaches or athletes – the opposition may be just too good! So getting children to concentrate on getting better at their skills is more productive in the long run. It will keep more children interested, allow them to deal with losing, and enable them to set attainable targets. Then they are more likely to enjoy the sport and come back for more.

To help you to be clear about your own values let me turn to some outcomes of a research programme we have been conducting at Brighton in the last few years. Building upon the work of Schwartz and Rokeach we developed a questionnaire to measure values among young athletes (Lee *et al.,* 2000). Then we examined the relationship between values and motivational orientation. To do this we used three groups of values - Competence, Moral, and Status values - that seemed to underlie positive and negative attitudes in sport. Thus, we can ask a short series of questions about which is most important when set against each of the others. For example: Do I think it is more important to be good than fair? Do I think it is more important to be a winner than good at the sport? and, finally, do I think it is more important to be a winner than fair? The answers to these questions will influence how you coach and the model you present to your athletes. Of course, it may not be that these values are necessarily mutually exclusive. It may be possible to accommodate a desire to be competent, to be fair, and to be a winner, but I would suggest that it demands a clarity of understanding and a willingness to explore the values that guide one's behaviour with honesty and consistency.

We have been able to show that, among young athletes, the values of competence, morality, and status are important in determining pro-social and anti-social attitudes (Lee *et al.,* 2001). The pro-social attitudes were exemplified by a respect for the conventions of sport and commitment; anti-social attitudes by cheating and gamesmanship[1]. Furthermore, the effects of competence and status values operate through the dominant motivational perspectives that athletes use to assess their success or failure.

The interpretation of success seems to be made by reference to one of two styles known as task motivation and ego motivation. Those who adopt a task perspective see success in terms of self-referenced criteria such as improvement and the excellent performance of sporting skills. Those who adopt an ego perspective typically see success in terms of demonstrating superiority over others. winning. and they focus upon outcomes rather than performance. This might be summarised by distinguishing between 'doing' one's best as opposed to 'being' the best. These are not necessarily mutually exclusive; the best competitors may exhibit characteristics of both and be able to switch from one *state* to another as the occasion demands.

In our research, we have shown a pattern of relationships among values, motivational perspectives, and attitudes among young athletes. First, socio-moral values directly effect both positive and negative values. Second, competence values determine positive attitudes through the mechanism of a task orientation to the interpretation of success. Third, status values determine negative attitudes through the mechanism of an ego orientation to the interpretation of success (Lee *et al.,* 2001). Therefore, we could expect that if we can develop values in young athletes that emphasise pride in performance, development of skills, and a desire to improve, then the dominant motivational perspective will be one in self-referenced criteria are used to determine success and result in more positive attitudes towards participation. If, however, we place more emphasis on the status and prestige to be gained from sporting success we will encourage comparative criteria to determine success – we must be better than others in order to be good. This may then result in negative attitudes to sport participation; that is, a resort to cheating and gamesmanship.

Putting it into practice

Having attempted to clarify our own values, identified what we are really trying to achieve when we coach children - and knowing that coaches are major contributors to the values that children adopt in sport (Lee and Balchin, 1996) - we need to ask how do we actually transmit our values to others and help them to develop them. The transmission of values is a subtle

[1] Gamesmanship is a term that refers to manipulation of the rules, officials or opponents to gain an unfair advantage. Stephen Potter first articulated it in his book 'Theory and practice of gamesmanship, or the art of winning without actually cheating.' London: Hart-Davis, 1947.

aware that it does not proceed in one direction. Our values are subject to examination and influence by the everyday interaction with others, be they children or other adults (Coles, 1998). We may find that in coaching children the values that we hold are challenged by the behaviour of others involved in the process – parents, children, other coaches, and administrators. This very challenge forces either a defence of, or a change in, often deeply held beliefs.

So, what can we learn from that? Perhaps it is important to be aware of those beliefs and understand how they are translated into action such that the youngsters we work with can see them in practice. If we believe that winning competitions is the primary reason for doing sport then we will encourage only winners, pursue competitive success at all times, reject those who are improving but not quickly enough, and take advantage of every situation. If we believe that sport is also concerned with developing young people to do their best, we will reward improvement, effort, and commitment. We will encourage every athlete - not just the best - set individual targets of performance, and support our athletes even when they fall short. If we value fairplay and sportsmanship we will demonstrate it in all that we do; show respect for players, opponents, officials, the rules of the game (Vallerand *et al.*, 1997) and demand the same of our players. We will not tolerate cheating or foul play or even gamesmanship.

The value of winning is an expression of the primacy of self-interested values interpreted as a demonstration of superiority over others. This seems to be a logical requirement of an élitist philosophy and herein lies a dilemma for the sports coach. Top professional and international sport depends upon, increasingly, an élitist philosophy and value system, yet very few of the children that we a work with can achieve or even aspire to that level of excellence. Therefore, coaches of young athletes must make a decision about how to use their resources to the best effect. Whether or not their primary purpose is to provide the material for sport as a business and for national teams? If so, it will require them to sift through the material available to them and to discard those who do not make the grade. If not, the alternative seems to be to try to help all their athletes to develop to the limit of their potential and then decide for themselves how far they wish to, or can, go.

These need not be mutually exclusive. It is possible to develop inclusive sports programmes that encourage children of all levels of ability to develop as far as possible while at the same time encouraging the most talented to progress further without it being at the expense of the less able (see for example De Knop *et al.*, 1994). However, it may not be possible for individual coaches to accommodate both groups at the same time. Some coaches may be better suited to working with the most talented while others may be better suited to working with the less able or the beginners. Knowledge of one's own strengths and weaknesses may be a key to understanding one's values and making the most of ones' abilities.

It seems unarguable that coaches should see that children enjoy their sporting experiences and encourage them to return for more. Research (e.g. Smith *et al.*, 1979; Lee and Austin, 1988; Theeboom *et al.*, 1995) has shown that this can best be achieved if coaches:

- Establish good relationships with the children.
- Are both firm and fair.
- Give positive feedback rather than negative.
- Teach skills.
- Keep a sense of humour.
- Get to know each child individually.
- Set challenging but reachable targets.
- Focus on doing as well as you can rather than winning.

By doing these things, children are encouraged to be responsible for their own learning, gain a sense of achievement, and will have fun. When that happens then we can expect them to return to develop their skills and perhaps become committed to the pursuit of excellence. Then sport will reap the rewards!

5. CONCLUSION

The argument that I have put in this paper is that coaches, and others responsible for the provision of children's sport, assume a position where their values must be examined and tested. This means that they must examine their personal values within the wider sphere of society and understand the roles that sport takes in the life of a nation and the individuals who comprise it. Thus, each of us must confront our own value system and define our own particular role in the sport system. Clearly, the importance of sport to national identity and to commerce throughout the world has grown remarkably since the days of Baron de Coubertin and the sport industry requires a constant supply of talented athletes. Nevertheless, it is not necessary that all children who do sport can, or would wish to, aspire to those levels. For most, sport provides a means of learning about themselves, of developing recreational, social, and physical skills, and perhaps of learning to become good citizens (see Telama and Liukonnen, 2001). Each of us has to make the decision of where we fit in to the overall picture. Unfortunately sport also provides an opportunity to violate the moral imperative; managers need to find good athletes to meet their own ambitions and athletes need to find good coaches to enable them meet their own goals. When we are dealing with children, however, we are in a position of power and authority that should not abused either by unfairly holding them back, prematurely advancing them, or by unfairly rejecting them. When making the important choices that face us let us hope that we can do so with the best interests of our young athletes at heart.

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PARENTAL INFLUENCES ON YOUTH SPORT PARTICIPATION

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1. INTRODUCTION

Millions of children engage in physical activity and participate in competitive youth sport programs around the world. Involvement in these programs provides important health benefits and helps children learn physical skills that they can use throughout their life. Through the social interactions in sport programs children build friendships and learn important interpersonal skills such as cooperation and teamwork. Sport involvement also provides an opportunity for children to develop characteristics and values that may assist with academic or personal growth as they mature (e.g. perseverance, commitment, dedication). While there are many benefits associated with sports involvement, there are also some potential downsides. The emphasis placed on achievement in our society can put excess pressure on children to perform in sports and physical activity. Because not all children have equal motivation or genetic potential for success at sports, some may experience negative emotions or develop negative self-perceptions through their involvement in athletics. The inherent social evaluation or public display of ability in sports must be carefully considered to ensure that children develop positive perceptions and have healthy experiences through sport participation (Scanlan, 2002).

In the past twenty years, considerable attention has been focused on the impact that parents have on their children's sport and physical activity experiences and the psychosocial development associated with such involvement (Brustad *et al.*, 2001). As a result, the knowledge base on the influence that parents have on young athletes is more comprehensive than ever before. This research consistently indicates that parents are critical agents in the process of children's sport socialization (Brustad and Partridge, 2002;

Greendorfer *et al.*, 2002). Mothers and fathers play a central role in the initial exposure of children to organized sport. They are generally the ones who seek out the opportunities, provide transportation, equipment and financial support. As children continue involvement in sport, parents not only maintain the provision of many resources, but also provide the necessary support and encouragement. Throughout this process, parents provide the primary source for filtering the meaning of sport experiences. Children come to believe in their abilities, have certain expectations of themselves and develop sport-related value systems based, in large part, on the attitudes and behavior of their mothers and fathers.

The influence from parents can be positive and negative depending on how it is received and perceived by the child. Praise, encouragement and support can help to enhance a child's perception of their ability and increase their interest and involvement. Pressure and criticism, on the other hand, can damage a child's confidence and take the inherent enjoyment out of the activity. Often there is a fine line between pressure and support, and parents need to learn how to provide the right type and amount of assistance. Parental attitudes (e.g., beliefs and values) and behaviors (e.g., involvement with child or personal physical activity engagement) can also impact youth experiences both positively and negatively.

This chapter reviews the research on parental influences in youth sport and physical activity. The first section describes the predominant theories that have been used to study and understand parental influence in youth sports. The second section reviews various sources of parental influence that have been studied and highlights the impact they have on children's interest and involvement in sports. Particular attention is given to the types of influence that are grounded in socialization and developmentally based motivational theories. More descriptive forms of influence such as support, parental evaluation and the perceived meaning of athletic participation are also discussed. This section uses the described theoretical frameworks to more clearly describe the mechanisms through which parents influence children's attitudes and perceptions. The last section presents an integrative model of parental influence that incorporates elements from the different theoretical frameworks. The model is presented as a guide to understanding the complex nature of parental influences in sports and physical activity programs.

The majority of literature on parental influences in youth sport has typically been oriented toward social or psychological constructs of the young sport participants, e.g., stress or perceptions of competence, and the impact of various beliefs and behaviors of parents on the particular construct of interest (Brustad *et al.*, 2001; Brustad and Partridge, 2002). In this review, the focus is instead on the nature of the various forms of influence exerted by mothers and fathers, and subsequently how these impact children's sport experience, emotional responses, and beliefs systems. An important distinction with previous reviews is that sports participation is viewed as a means to an end rather than as an end in itself. In other words, the primary goal of youth sport programs should be to provide positive experiences and support so that the child develops an intrinsic interest in sports and physical activity. The guidelines and recommendations presented emphasize how parents can help children develop positive perceptions and values from sport and develop lifelong interest in sport and physical activity participation.

2. THEORIES OF PARENTAL INFLUENCE

Theories provide a way to interpret results from research and field experiences. With respect to youth sports, theories of motivation and sport socialization serve as both frameworks for research and guides for planning and delivering programs. Research eventually accumulates to support or refute a given theory, and the collective information can then serve to guide practice.

This section reviews different theories used to explain motivation in youth sports. While the theoretical frameworks differ in a number of significant ways, they also share many common elements. Emphasis is placed on the commonalities among theories since this probably provides the best basis for enhancing the delivery of youth sport programs. Four theoretical frameworks are emphasized: competence motivation theory (Harter, 1978, 1981), attribution theory (Weiner, 1974, 1980), achievement goal theory (Nicholls, 1989), and expectancy-values theory (Eccles *et al.*, 1983).

COMPETENCE MOTIVATION THEORY

Competence motivation theory (Harter, 1978, 1981) is based on the notion that individuals have an innate need to experience feelings of competence. Competence can be achieved through mastery experiences in a variety of achievement situations but the child's perceived competence in a particular achievement situation or skill is the critical determinant. If the child feels competent, he/she will experience positive emotions and feelings, which will increase his/her intrinsic motivation or desire to participate in that sport or activity. If, however, the child does not feel competent in a specific situation, negative emotions can arise, anxiety is increased and motivation to participate is reduced. Competence and skill are both enhanced through repetition so that a critical factor for future motivation is willingness to engage in continued mastery attempts. If motivation is reduced, the child either does not pursue such mastery attempts or extrinsic motivation is necessary to continue involvement.

A major strength of competence motivation theory is that both socialization and developmental explanations of the psychological, emotional and motivational outcomes of children are considered. Studies on the sources of competence information for youth athletes (Horn and Amorose, 1998; Horn and Hasbrook, 1986, 1987; Horn and Weiss, 1991) have established that there is a developmental shift in the salience of significant others as a source of determining ability by children and adolescents. Prior to about 12 years of age, children tend to use feedback and reinforcement from parents and other significant adults (e.g. coaches) as the most important input in determining their own level of athletic competence. During early adolescence, the child looks less to the "authority" and develops self-perceptions based more on peer comparison and peer evaluation. With progress to late adolescence, perceptions of competence become more self-referenced. The adolescent now looks at the effort they exerted, level of attraction to the sport, as well as their personal goals and goal orientations. Therefore, there is a developmental shift from external sources to internal sources of information on which self-perceptions of ability are made. The transition to more external or peer-comparisons to assess competence is a normal developmental stage that occurs in concert with other cognitive and social stages.

ACHIEVEMENT GOAL ORIENTATION THEORY

The major contention of achievement goal theory is that individuals engage in an achievement situation to demonstrate competence (Duda, 1992; Nicholls, 1984, 1989). A distinction of this theory is that one's conception of competence is thought to be perceived differently depending on the goal orientation of the individual within the activity. The goal of an individual is related to his/her definition of success and subsequent achievement behavior. Two orthogonal goal orientations exist, ego and task. An individual may score high or low on both, or high on one and low on the other. An ego-oriented goal is one where competence is based on outperforming others or having superior ability. In contrast, task goals reflect an orientation where competence is determined based on self-improvement, effort, and the mastery of a task (Nicholls, 1989).

Whether one is task or ego involved is determined by two factors, goal orientations (dispositional) and motivational climate (situational) (Ames, 1992). Goal orientations refer to the individual's tendency to be either task or ego involved. These dispositional orientations are assumed to be the result of childhood socialization experiences (Nicholls, 1989) and are seen as the precursor for exhibiting a particular goal orientation. The motivational climate in a particular setting can also influence task or ego involvement. These situational constraints, typically determined by rules or by significant others within the environment, establish criteria for success or failure that are either task or ego involved (Ames, 1992). These environmental factors can potentially alter the dispositional probabilities and influence motivations.

Two types of climate exist, performance and mastery. Performance climate, focuses on ego involved criteria for success or failure while mastery climate encompasses task-involving criteria. Individuals are "predisposed" by their own goals towards a particular orientation, but it is the environment that surrounds that individual that can change the orientation. Significant others, such as parents, coaches, teachers and peers, in an athlete's life structure the motivational climate. If a parent praises the child for competence and success (placing the emphasis on competition above effort), the child infers a performance-oriented environment and typically will give low levels of effort, avoid challenges and eventually give up in achievement situations (Ames, 1992). This performance-oriented environment has been associated with higher levels of ego orientation (Ames and Archer, 1988), which leaves children evaluating themselves based on wins and losses. If on the other hand, parents and teachers foster an environment that is mastery-oriented, children will develop a higher task orientation and in turn, retain their intrinsic motivation, regardless of their level of ego-orientation. Duda (1997, p. 309) has suggested that high levels of task orientation are essential for youngsters to help motivate them over an extended period of time as well as give them motivation when their "normative ability is in jeopardy."

ATTRIBUTION THEORY

Attributions are reasons or perceived causes people give for the outcome of an event either related to them or others. Attribution theory states that people examine motivation based on attributions made about performances. Although Fritz Heider is considered the founding father of attribution theory, Bernard Weiner's work has made exceptional contribution to attribution research, most significantly in regard to attribution processes associated with achievement situations. Therefore, focus is on the model of attribution described by Weiner (1974, 1980).

The original attribution model (Weiner, 1974) focused on two dimensions, locus of control (internal or external) and stability (stable or unstable). An internal locus of control is associated with individual characteristics, such as ability or effort, whereas, external would be associated with influences outside the individual's control, such as luck or task difficulty. For stability, attributions associated with permanent, long-term explanations are labeled stable (e.g., ability or task difficulty) while attributions that are changing and variable are unstable (e.g., luck and effort). In 1979, Weiner added a third dimension, which was labeled controllability, and the original 'locus of control' dimension was renamed as locus of causality.

Each of the three dimensions plays an important role in explanations for achievement outcomes. Most often athletes will use a self-enhancing justification to explain a given outcome. Therefore, success would generally be attributed to internal factors (typically a combination of ability and effort), whereas failure would be attributed to external factors such as task difficulty or luck (Robinson and Howe, 1989). The stability of attributions may vary depending on how consistently a team wins or loses. Little League baseball players who had consistently lost attributed the losses to ability, but teams who had consistently won attributed the wins to ability and did not see their ability as less when they lost (Roberts, 1975). Further, individual players attributed themselves to have exhibited high effort, but their other team members to have lower effort.

EXPECTANCY-VALUE THEORY

A framework that has been particularly useful in the study of parental influence is the expectancy value framework proposed by Eccles and colleagues (1983). This framework, based originally on social learning theory, takes a broad perspective by emphasizing the factors that underlie parental socialization efforts with children rather than the specific effects that their influence has on children. Parents are viewed as both interpreters and providers of experience for children. Thus, parents shape a child's interests, beliefs and self-perceptions by providing access to various experiences and by influencing the child's interpretation of these experiences. Parental socialization efforts are thought to be dependent on the parents' expectation for their child's success and the value that parents place on success in this behavior. Thus, if parents expect that their child can be successful and value his/her success in this behavior, they will be more likely to socialize their child to pursue and excel at this behavior.

The model has been particularly effective at explaining gender differences in socialization from parents. If parents have differential values and expectations for boys and girls in a particular domain they will be more likely to support and encourage their child to work hard in this area. Gender differences in parental socialization influence have been reported in both academic (Eccles, Adler, & Meece, 1984) and sport domains (Eccles & Harold, 1991). The model has also been successfully applied to studies of children's physical activity (Brustad, 1996; Dempsey, Kimiecik, & Horn, 1993; Kimiecik, Horn, & Shurin, 1996; Kimiecik & Horn, 1998).

Recent research has integrated the Eccles framework within a broader Family Influence Model to examine the impact of parental beliefs on children's activity. They have demonstrated that parental beliefs are important predictors of children's activity (Kimiecik and Horn, 1998) and have documented that parental beliefs are influential only to the extent that children adopted the same belief system (Kimiecik et al., 1996). The framework provides a useful guide to understand the factors that influence the differential support and encouragement that parents may provide in physical activity and sport.

SUMMARY OF THEORIES OF PARENTAL INFLUENCE

Each of the theories provides an alternative view to explain factors that influence socialization process into youth sport and physical activity. Each theory addresses the issue from of a sllightly different angle, but there are a number of common elements. All of the theories place great importance on children's perception of competence or ability. This construct may be operationalized in different ways, but it is clear that children's self perceptions of their abilities is an important determinant of involvement and enjoyment in sports and physical activity. Another common element is that parents play an important role in shaping a child's attitudes and perceptions. Parents influence a child's perception of competence, goal orientations, and attributions a child makes about his/her ability.

3. THE NATURE AND IMPACT OF PARENTAL INFLUENCE

Considerable research has been conducted to examine the links between parents' beliefs and behaviors and children's psychosocial development in sport. The specific types of influence that parents have on their children in sport are numerous and diverse. Theoretically grounded and empirically based studies have identified particular parental beliefs and behaviors that are relevant to participation patterns, emotional responses, self-perceptions, and motivation of young athletes. Table 1 summarizes the sport-related parental influence research organized by the particular constructs which have emerged: Consistent with the focus of this book, the behaviors and beliefs of mothers and fathers that are related specifically to children's competitive athletic participation rather than more broadly to their physical activity involvement are emphasized.

PARENTAL PRESSURE AND EXERTION

Inquires of the pressure, expectations and the degree of intensity that mothers and fathers place on their children for sport achievement and involvement has generated considerable research. Overall, children's interpretations of the particular form of parental influence vary substantially. This variability, in turn, contributes to sport-related emotional and motivational outcomes. The forms of influence that have emerged include parental pressure, expectations, and directiveness.

Table 1. Types of Parental Influence Studied in Youth Sport

CONSTRUCT	REFERENCES
I. Parental Exertion	
Pressure	Babkes and Weiss (1999), Brustad (1988) Gould *et al.* (1991), Hellstedt (1990), Leff and Hoyle (1995) Scanlan and Lewthwaite (1984, 1986)
Expectations	Averill and Power (1995), Eccles and Harold (1991), Green and Chalip (1997), Power and Woolger (1994), Scanlan and Lewthwaite (1984)
Directiveness	Averill and Power (1995), Power and Woolger (1994)
II. Parental Beliefs	
About Competence	Babkes and Weiss (1999), Felson and Reed (1986), McCullagh *et al.* (1993)
About value of competence	Eccles and Harold (1991)
About appropriatenss of sport participation	Brown *et al.* (1989)
About goal orientations	Duda and Hom (1993), Ebbeck and Becker (1994). White (1996)
III. Parental Responses to Performance	
Satisfaction	Scanlan and Lewthwaite (1986)
Negative Evaluation	Brustad and Weiss (1987), Brustad (1988), Lewthwaite and Scanlan (1989), Passer (1983), Weiss *et al.* (1989)
Performance Reactions	Babkes and Weiss (1999), Hellstedt (1990), Scanlan and Lewthwaite (1986)
IV. Parental Behaviors	
Interactions	Scanlan and Lewthwaite (1986), Scanlan *et al.* (1989)
Involvement	Babkes and Weiss (1999), Feltz *et al.* (1992), Ommundsen and Vaglum (1991), Scanlan and Lewthwaite (1986)
Encouragement	Brown *et al.* (1989), Green and Chalip (1997)
Support	Averill and Power (1995), Brown *et al.* (1989), Leff and Hoyle (1995), Power and Woolger (1994), VanYperen (1995).
Role Modeling	Babkes and Weiss (1999), Brown *et al.* (1989), Power and Woolger (1994), Wold and Anderssen (1992)

Parental pressure is a commonly discussed form of social influence in the pediatric sport psychology literature. Although there is no single consistent definition, the exertion of pressure by mothers and fathers has typically been conceptualized in a manner that reflects children's "perceived parental expectations, how critical parents are, their response to loss / defeat, parental concerns about winning, and the pressure parents put on them to succeed" (Leff and Hoyle, 1995, p. 192), or the "amount of motivational influence the parent exerts on the child-athlete to compete in sports, perform at a certain level and continue sport participation" (Hellstedt, 1990, p. 136). Regardless of exact definition, children have primarily responded to survey questions similar to those asked by Scanlan and Lewthwaite (1986) and (Brustad, 1988, p. 312): "My parents get upset with me when I do not play well," and "My parents think I should be a lot better in basketball than I am," to indicate the level of pressure that they perceive their parents exert.

The impact of perceived parental pressure has been examined in relation to an array of psychosocial outcomes, such as participation and motivation, but has mostly focused on the impact that perceived pressure has on emotional responses in sport (Babkes and Weiss, 1999; Brustad, 1988; Gould *et al.*, 1991; Hellstedt, 1990; Leff and Hoyle, 1995; Scanlan and Lewthwaite, 1984, 1986). Young athletes who perceive high levels of pressure from their parents also experience higher levels of negative emotional responses. Lower levels of perceived pressure are consistently associated with more positive emotional responses to sport participation.

In an early, somewhat atheoretical, examination of sources of stressors among young athletes, Scanlan and Lewthwaite (1984) found that perceived parental pressure to participate in wrestling was predictive of pre-match stress among 9-14 year old males. Using the same questions to explore the impact of pressure, Gould *et al.* (1991) reported similar results. Perceived parental pressure to wrestle was a significant antecendent of pre- and post-match competitive state anxiety in early adolescent male wrestlers. In related research designed to test the relationship between significant others and affective responses to competence seeking endeavors in children, Brustad (1988) found that lower perceptions of parental pressure among male and female youth basketball players predicted high levels of season long enjoyment.

Research on parental pressure indicates that children perceive their mothers and fathers exertion of this form of influence differentially. In a study grounded within competence motivation theory, Babkes and Weiss (1999) found a disparity in perceived pressure based on parental gender. While perceptions of maternal pressure did not contribute significantly to the relationship between parental influence and male and female children's soccer-related psychosocial outcomes, perceptions of lower paternal pressure to perform was associated with higher enjoyment, perceptions of competence and indicators of intrinsic motivation among young competitive athletes. In a study of young tennis players, Leff and Hoyle (1995) reported similar gender differences. Higher levels of pressure were attributed to fathers as compared to mothers for male players, whereas females perceived similar levels of pressure from mothers and fathers. Scanlan and Lewthwaite (1986) found higher levels of enjoyment among 9-14 year old male wrestlers associated with lower levels of perceived maternal pressure. The findings thus suggest that the impact of perceived parental pressure varies according to the gender of the parents and young athletes being assessed.

In a detailed examination, Hellstedt (1990) reported that over 70% of highly competitive young skiers expressed that their parents exerted moderate to forceful level of pressure to compete and not withdraw from sport. Consistent with other research, high perceived parental pressure was associated with negative affective reactions among both the male and female athletes. Although high levels of perceived parental pressure were more likely to elicit a negative emotional reaction, the author interestingly concluded that many athletes did not actually view this pressure as truly negative. In fact, some of the athletes expressed that the amount of pressure exerted by parents served as a form of support and was construed as positive in terms of enhancing their sport performance.

Parental expectations of their children's sport participation and performance are another frequently studied form of parental pressure. In the context of sport, expectations are conceptually similar to "pressure", but they are operationalized and interpreted differently. Expectations have generally been defined as "parents' specific performance goals or the extent to which parents want the child to become a successful athlete as opposed to being satisfied as long as child has fun" (Averill and Power, 1995, p. 168; Power and Woolger, 1994, p. 62).

Research on the impact of perceived parental expectations is equivocal. For example, Scanlan and Lewthwaite (1984) found that young male wrestlers who reported more frequent worry about meeting parental expectations experienced higher state anxiety prior to competition than peers who did not experience the same worries. Others, however, have found that young soccer players who perceived their parents to have high expectations for them in sport reported higher levels of perceived soccer ability and enjoyment (Averill and Power, 1995; Green and Chalip, 1997). Parental performance goals or expectations had a curvilinear relationship with children's enthusiasm and enjoyment in age-group swimming (Power and Woolger, 1994).

The data appear to indicate a threshold of perceived parental expectations. A moderate level of performance and success expectations is beneficial and related to positive sport-related responses. Expectations that are perceived as too high, or those that are accompanied by considerable worry about meeting parental hopes and dreams, may in fact be detrimental to social, emotional or psychological responses experienced by youth athletes.

The influence of expectations appears to differ depending on whether they come from mothers or fathers. Maternal performance expectations were positively associated with young children's soccer enjoyment, while fathers' expectations or performance goals were negatively associated with their ratings of their child's effort (Averill and Power, 1995).

Research grounded in theories such as the expectancy-value theory provides a way to understand and predict the impact of parental expectations on young athletes. Findings from a three year longitudinal study of the relationship between parental beliefs and children's self-perceptions and activity choices revealed that perceptions of parental expectancies were significant predictors of children's perceptions of competence. Perceptions of competence, in turn, were related to the choices that children made in choosing to participate or not participate in particular activities. More specifically, children who perceived that their parents thought they were athletically competent and expected them to choose to play sports believed that they were able in sport and subsequently chose to be involved in athletics. Further research is needed to expand our understanding of the critical role that parental expectations play in children's athletic involvement.

Parental directiveness is defined as the "degree to which parents actively instruct their child about how to approach achievement tasks with an emphasis on areas in need of improvement " (Averill and Power, 1995, p. 268; Power and Woolger, 1994, p. 62). It has been the focus of some research on the social exertion that young athletes receive from their parents. Parents who engage in directiveness typically tell their children what to do whether it is solicited or not. A statement such as "Before a meet, I remind my child of what he/she needs to work on," would be indicative of high directiveness, while a statement such as "I give my child advice about how to improve in swimming only when he/she asks for it," is an example of low directiveness.

Too much or too little parental directiveness is associated with low levels of sport enjoyment and effort. The impact, however, may differ by parental gender. Paternal directiveness was highest when children's effort and ability was low, but maternal directiveness was not associated with children's psychosocial outcomes (Averill and Power, 1995). Reported parental directiveness had a curvilinear relationship with enjoyment among age-group swimmers of both sexes (Power and Woolger, 1994). Apparently, the impact of the amount of mother- and father-imposed directiveness is similar to the amount of perceived expectation in terms of how beneficial or detrimental these forms of influence are on young athletes.

It appears that the interpretations and perceptions of parental pressure, expectations and directiveness by young athletes are related to their experiences in the sport. Further research is needed to determine the degree to which these forms of influence should be encouraged and/or curtailed among parents so that children engage in sport in a psychosocially healthy manner.

PARENTAL BELIEF SYSTEMS

Through the assessment of various types of beliefs, research overwhelmingly suggests that children's interpretation of their parents' beliefs about competence, or how success is demonstrated, that matters with respect to psychological, social or emotional responses. Parental beliefs about their child's athletic competence or ability, relative value of sport participation, achievement goal orientations, and perceived appropriateness of athletic involvement are specific forms of influence that have emerged from this domain of study.

With little exception, exploration into the relationship between parental beliefs about children's sport ability and children's own perceptions of athletic competence has been grounded in competence motivation theory. Findings from two studies provide strong support for the utility of this framework as a useful way to understand parental influence in sports. McCullagh *et al.* (1993) found a correspondence between parental perceptions of their children's soccer competence and the young athlete's own ratings of ability in soccer. Babkes and Weiss (1999) noted a positive association between higher perceptions of parental beliefs about soccer competence and children's perceptions of soccer ability, soccer enjoyment and intrinsic motivation.

Felson and Reed (1986) examined the influence of parental belief systems on children's own self-perceptions from a reflected appraisal approach (Mead, 1934; Cooley, 1902). The findings were consistent with subsequent research in that parental appraisals had an effect on 4th through 7th grade children's self-appraisals of how well they did at sports. There was a differential influence between the impact of mothers and fathers on children's self-appraisals of sport ability. These results possibly reflect a developmental change in social influence. Younger athletes expressed that they perceived equal levels of perceived parental appraisal in ability when comparing mothers and fathers. Among older children, however, mothers maintained a significant influence with sons, but declined with daughters. Fathers' influence over daughters' self-reflected appraisal increased. These findings suggested that there was greater cross-sex influence in older children when considering parental appraisals of children's appraisals of their own ability.

The value that mothers and fathers place on being competent in sport is another parental belief system that has been examined. In Eccles and Harold's (1991) study, a large sample (n= 875) of children answered survey questions focused on "how important they thought it was to their parents that they do well in sports, math and English," and "whether ability in each area was more important for boys, for girls, or both" (p. 24). The findings from this study, which was grounded in expectancy-value theory, revealed that boys thought it was not only more important to their parents that they do well in sports than girls, but they also thought it was more important to their parents that they participate in sport than girls.

Eccles and Harold (1991) concluded that the extent to which male and female children thought their parents valued sport competence was directly related to the level that they rated their own sport competence. Children's views of the importance that their parents attach to involvement in sport related to their own sense of athletic ability. Children who believe that their parents think it is important for them to do well in sports, rate their own ability in sport as being higher. Essentially, perceptions of parents' expectancies and values were significant predictors of children's own value and ability beliefs. These findings further help to explain why children chose to participate in the activities they engage in.

Parental beliefs about how acceptable sport participation is for males and females is another form of influence. The premise in this line of research is that physical endeavors have been viewed as more masculine in nature and this attitude is maintained when parents consider appropriate sport participation for their children. Participation by adolescent Canadian females in intramural, interschool and community sports, for example, was associated with the girls' perceptions that their fathers viewed sport as an "appropriate" activity for them (Brown *et al.*, 1989). The view that parents, especially fathers, have about the appropriateness of daughters' activity choices appears to have an impact on continued involvement in sport. Although this particular study was not grounded in a particular theoretical framework, the findings are consistent with the contentions of Eccles *et al.* (1983) regarding the effects of value socialization on activity choice behavior. Continued research is necessary to fully understand the dynamic nature of how parents convey their beliefs about appropriate and valuable endeavors to their children.

A number of studies have supported the utility of goal achievement theory and examined the influence of parents' beliefs about success, or goal orientations, has on children's sport involvement. Children tend to adopt similar belief systems about success in sport as those of their parents. Ebbeck and Becker (1984), for example, found that parental goal orientations were dominant predictors of player goal orientations. Specifically, player task and ego orientations could be predicted by whether they perceived their parents to define success in self-referent or norm-referent terms. Level of task orientation of young soccer players was predicted by their own perceptions of competence and, more importantly, by perceiving that their parents had a high level of task orientation. Athletes who perceived their parents to have a high ego orientation were likely to believe that success was demonstrated in a norm-referenced manner.

Duda and Hom (1993) also found that the goal orientations male and female summer basketball camp participants were related to their views concerning the goal orientations adopted by their parents or how their mother or father defined success and judged competence in sport. High task oriented children perceived their parents to be more task oriented and high ego oriented children perceive their parents to be more ego oriented.

White (1996) extended the previous research on goal orientations among parents and their children and explored the parent-initiated motivational climate among adolescent female volleyball players. Results revealed that athletes who perceived that their parents emphasized success without effort were more ego oriented in their beliefs about success in sport. Athletes who were more task oriented, however, perceived their parents as fostering a climate that focused on learning and enjoyment.

Overall, perceptions of what parents believe about their child's ability and the value or appropriateness that they convey regarding athletic participation seem to be similarly believed by young athletes. The beliefs that parents convey about the goals of participation and how success should be determined are also consistently related to athlete's orientation toward participation and performance in sport. More research is necessary to thoroughly comprehend how this correspondence in parent-child beliefs is created and maintained.

PARENTAL RESPONSES TO PERFORMANCE

Responses of parents to their children's sport performances are another form of influence. Presently available evidence suggest that children's perceptions of their parents' responses and the contingency of parental reactions to performance are directly related to psychosocial outcomes in sport. The more favorable and contingent the parental response, the more young athletes are likely to report enjoyment and less stress.

Only two studies to date have attempted to actually examine perceived parental satisfaction with youth sport performance. In studies of competitive young male wrestlers, Scanlan and Lewthwaite (1984, 1986) assessed whether stress and enjoyment were predicted by perceived parental satisfaction with their season long performance. Although parental satisfaction did not emerge as a factor related to stress, greater perceived parental satisfaction with season performance was associated with higher levels of sport enjoyment.

Children's perceptions that parents would evaluate their performance negatively, or not express satisfaction in response to their demonstration of sport ability, have also been examined. Worry about potential negative parental evaluation is the construct that has most often been assessed. Worry of this kind is consistently associated with unfavorable emotional responses, such as stress or anxiety. Brustad and Weiss (1987), for example, found that young male baseball players who were high in competitive trait anxiety were more likely to have a high frequency of worry about incurring negative evaluation from their parents in the event of a poor performance compared to their less anxious peers. Brustad (1988) noted that male and female basketball players who were more competitively trait anxious worried more about receiving negative evaluations from others, such as parents. The highly anxious young athletes also perceived worry about evaluation as emotionally aversive.

Weiss *et al.* (1989) examined the relationship between precompetition anxiety among competitive male gymnasts and worry about negative social evaluation as well. Results revealed that the athletes' most worrisome precompetition thoughts were related to concern over receiving negative evaluation based on their performance from their parents. The two specific worries were, "what my parents will think" and "letting my parents down". Worry over anticipated negative evaluations from parents has consistently been associated more often with children who are highly trait anxious in competitive situations (Brustad, 1988; Lewthwaite and Scanlan, 1989; Passer, 1983). Therefore, the perception of frequent negative evaluations from parents and the subsequent impact on young athletes' sport experiences may, in fact, be mediated by children's disposition.

More general parental reactions to performance or responses contingent on the performance of young athletes has also been examined. For most part, these reactions have been described in the context of "...the affective and behavioral reactions demonstrated by parents following children's display of sport ability" (Babkes and Weiss, 1999, p. 49). Using this operational definition, there was a positive relationship between perceptions of mothers and fathers provision of frequent positive performance contingent responses to performance success and competitive soccer players psychosocial responses. The findings are consistent with previous results that young competitive male wrestlers who reported fewer negative maternal performance reactions experienced more enjoyment (Scanlan and Lewthwaite, 1986).

PARENTAL BEHAVIORS

The impact of parental behaviors on children involved in sport has also been studied. Parental behaviors include interactions, involvement, encouragement, support, and role modeling. Most of these behaviors appear to be perceived by children as positive in nature and have thus been considered to enhance the psychosocial outcomes and development of youth involved in sport. The most general forms of parental behavior that are likely to impact children's achievement pursuits are interactions which occur between parents and their children. To date, Scanlan and Lewthwaite (1986) and Scanlan *et al.* (1989) have explored parent-child interactions in the context of sport in young wrestlers and elite figure skaters, respectively. A lower frequency of negative maternal interactions perceived by young competitive male wrestlers was predictive of higher sport enjoyment. And, among former elite figure skaters, athletes experienced enjoyment as a result of bringing pleasure and pride to family through their sport achievement and engagement. The results suggest that an athlete's ability to use sport as a mechanism for creating positive interactions with significant others is an important source of enjoyment for them. Although these findings intimate that parent-child interactions have the potential to optimally impact youngsters' sport experiences, further research is warranted to more thoroughly understand the range of nature of this interplay.

Parental involvement in children's athletic endeavors has been examined more thoroughly than parent-child interactions. Involvement has been defined as "the extent to which parents took part in their child's sport participation either directly (i.e., giving instruction) or indirectly (i.e., attending games)" (Babkes and Weiss, 1999, p. 49), or as "encouragement, rearrangement of the family schedule to accommodate running, took them to practices and meets, attended practices and meets, gave them advice/instruction and inquired about their progress" (Feltz *et al.*, 1992, p. 130).

Findings suggest that children who perceive that their mothers and fathers are highly engaged in their sport activity tend to report more positive emotional responses and higher levels of perceived competence and motivation. For example, young male wrestlers who reported more involvement from adults, such as parents, enjoyed competitive wrestling (Scanlan and Lewthwaite, 1986), and the enjoyment of adolescent Norwegian soccer players was positively related to perceived emotional involvement of their parents (Ommundsen and Vaglum, 1991).

In one of the only longitudinal studies of parental influence, Feltz and colleagues (1992) observed no differences in perceptions of parental involvement by adolescent male and female distance runners. The degree of maternal versus paternal involvement, however, was perceived to be different. The runners expressed that fathers were more involved, i.e., attending races and showing interest, in their running than were mothers. Additionally, the amount of parental involvement in the adolescents' competitive running was perceived to decrease over time and with age in both males and females. Babkes and Weiss (1999) more recently found support for the perceived differential impact of maternal and paternal involvement. Athletes whose fathers were perceived as being more involved in their children's soccer, had more positive psychosocial responses. Maternal involvement did not significantly impact motivation, enjoyment or perceived competence of the children.

The encouragement provided by mothers and fathers for children's sport performance and involvement is another important behavior. The receipt of parental encouragement has been associated with positive athletic experiences for youth. Green and Chalip (1997) found that higher perceptions of parental encouragement among young male and female soccer players had a significant effect on children's satisfaction and involvement in soccer. Brown *et al.* (1989) found that the higher the encouragement that girls perceived from their parents, the more continuity they maintained in intramural, interschool and community sport involvement.

Parental support is another frequently studied behavioral construct that has been operationalized in several ways. One commonly used definition is as follows: "...providing emotional support for child's soccer playing regardless of performance" (Averill and Power, 1995, p. 168; Power and Woolger, 1994, p. 62). A number of studies have examined the correlates of perceived parental support to determine the effect on sport-related outcomes and behaviors. Maternal support was positively related to level of enjoyment for soccer among their sons (Averill and Power, 1995). Parental level of support was also positively related enthusiasm among age group swimmers of both sexes (Power and Woolger, 1994). Among adolescent girls higher perceptions of support for involvement in sport, especially as they grew older, were associated with stronger continuity of sport participation (Brown *et al.*, 1989). Support for involvement from fathers in particular was a significant predictor of the sustained athletic involvement among these adolescent females. For young male and female tennis players, perceived parental support was associated with higher levels of enjoyment and self-esteem (Leff and Hoyle, 1995). Among elite male soccer players, when perceived parental support was low, the players experienced more negative feelings about the team following low performances (Van Eyperen, 1995). In other words, the players did not suffer from as much interpersonal stress following a poor game when they felt that their parents were more supportive. Results of this series of studies suggest that parental support serves to "buffer" the effects of interpersonal stress when a negative performance occurs and enhances the overall positive experiences for children involved in athletics.

Parental role modeling has repeatedly been related to children's sport participation. Studies suggest that children whose parents took part in sport or physical activity were more likely to take part in athletics themselves. Couched within a socialization theory perspective, Wold and Anderssen (1992) found that among European schoolchildren sport participation of similar sex family members was more strongly associated with their sport participation than the opposite sex, while Brown *et al.* (1989) reported that mother's role modeling or same sex participation in sport was a significant predictor of continued athletic involvement by adolescent females. Babkes and Weiss (1999) found that competitive male and female soccer players who perceived their mothers and fathers as more positive role models through their own physical activity reported more enjoyment, higher perceptions of competence, and more intrinsic motivation.

As with other social influence constructs, the impact of role modeling behaviors appears to have a differential effect depending on the gender of the parent and the child. In a study of age-group swimmers and their parents, Power and Woolger (1994) found a positive relationship between mother-modeling and sport enthusiasm among both males and females. There was, however, a negative association between father modeling and enjoyment among male swimmers.

SUMMARY OF PARENTAL INFLUENCE IN SPORT

In summary, parents who provide more support or encouragement, respond positively when it is contingent with performance, model active lives, believe that their children are athletically competent, and exert lower levels of pressure or expectations have children who worry less, experience more enjoyment, believe they are capable in sport and are intrinsically motivated in their sport endeavors. In contrast, parents who exert high levels of expectations and pressure, respond negatively to performance, interact poorly, believe that their children are not particularly able in sport and do not model active lives are more likely to have children who experience more stress, less enjoyment, believe they are less competent, more extrinsically motivated, and more likely to cease participation.

It is the young athletes' perceptions of parental influence that matters most with regard to healthy sport experience and psychosocial development. Children's' perceptions of parental attitudes and behaviors are more strongly related to children's enjoyment, perceptions of competence, and motivation than parental reports of their own influence (Babkes and Weiss, 1999). In other words, regardless of how supportive or how little pressure parents think they place on their children to achieve success in sport, children may interpret events and beliefs differently. While these findings may seem to place mothers and fathers at a loss for how to actually parent their children effectively in pursuit of sport achievement, the results indicate the importance of understanding how parents and children communicate to bring about healthy sport experiences. Research to date, however, has yet to thoroughly understand the dynamics of communication patterns between parents and their children involved in sport.

It is also important to distinguish the differential influence of mothers and fathers on their children, and more specifically how this may differ for boys and girls. Although a few studies have focused on the relative influence of each parent, the majority of findings summarize the combined influence of both parents rather than the separate or differential influence. In addition to recognizing the changing structure of family, Greendorfer (2002) recently highlighted the extent of the difference that mothers and fathers conceivably have on their children's sport socialization. The nature of the effect that dominant gender ideology has historically had on both the sport socialization of females and the role that mothers play in their children's sport endeavors are changing. Historically, salient maternal influences have include support, encouragement, and more nurture-related forms of influence, but increasing trends in maternal employment might result in changes with respect to how mothers and fathers, respectively, contribute to their children's achievement. Furthermore, the potential changes in parenting roles may also result in changes in children's gravitation toward sex-typed activities given the alteration on gender-related patterns of engagement by their mothers and fathers. Given that sport is often perceived as more valuable and expected among males and that females are still more frequently exposed to activities that accentuate qualities that are "feminine", understanding the relative influence of mothers and fathers on the sport experiences of both young males and females is an important direction for future research.

Understanding parental influence in youth sport is limited by the lens with which this topic is viewed. The majority of research has been conducted on Caucasian, two-parent families of primarily middle and upper socioeconomic status where the youth sports participants are able-bodied and without cognitive deficits. The lack of diversity in the extant research inhibits the ecological validity of the findings to a broader array of families involved in the athletic arena. To date, data are not available about the parent-athlete relationship in single parent families, for those of relatively low socioeconomic status, or for the child with physical or cognitive limitations who is involved in sport.

4. AN INTEGRATIVE MODEL OF PARENTAL SOCIALIZATION INFLUENCE IN SPORTS AND PHYSICAL ACTIVITY

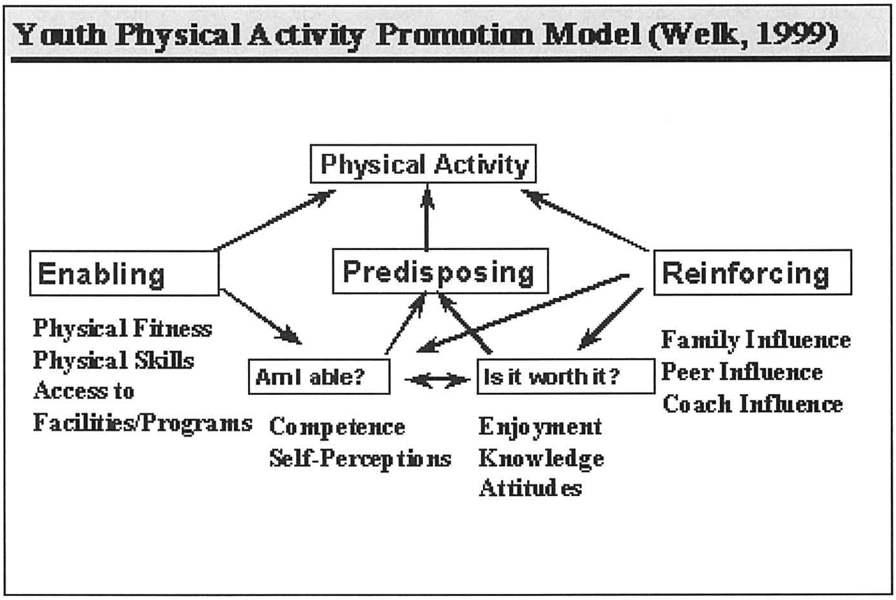

Figure 1. Youth Physical Activity Promotion Model

This section describes an integrative model that summarizes the processes involved in youth activity promotion. The model is based on the conceptual framework previously described as the Youth Physical Activity Promotion Model (Welk, 1999). The model is expanded to describe more specifically how and why parents socialize their children into sport and physical activity (Figure 1).

A basic premise in the model is that parents influence children both directly and indirectly. Direct effects may be through involvement or facilitation of a child's efforts or involvement. Parents enroll children for sports and provide the equipment, transportation and financial support to continue being involved. Parents also indirectly influence a child's interest and involvement in sports and activity. In this model, it is proposed that this effect is mediated through two distinct social-cognitive based constructs, outcome expectancies and efficacy expectancies. These two constructs are operationalized as "Is it worth it?" and "Am I Able?". To maintain interest and involvement in sports and physical activity, children need to be able to answer both questions in the affirmative. If children believe that sports are "worth it", but they are not skilled enough to participate they are not likely to participate. Similarly, if children feel competent in an activity but do not find that their involvement is worthwhile, they will not maintain involvement.

Consistent with the expectancy-value framework (Eccles *et al.*, 1983), it is proposed that the degree of parental socialization influence is determined by the values and expectancies parents have with regard to sport and physical activity. Parents with more favorable values and expectancies are more likely to model appropriate activity behavior, promote involvement, and provide necessary social support and encouragement (Figure 2). The impact of these socialization efforts, however, depends on how they are perceived or internalized by children. Those who perceive positive values and expectancies from their parents are more likely to develop more positive perceptions of competence and to be more attracted to sport and physical activity. On the other hand, children who perceive more negative values and expectancies are more likely to have poorer perceptions of competence and may lose interest in sport and activity.

The principles derived from competence motivation, attribution, and achievement motivation theories should serve as a guide for how to provide feedback, instruction and support to children in the sport and physical activity settings. Several examples are subsequently considered.

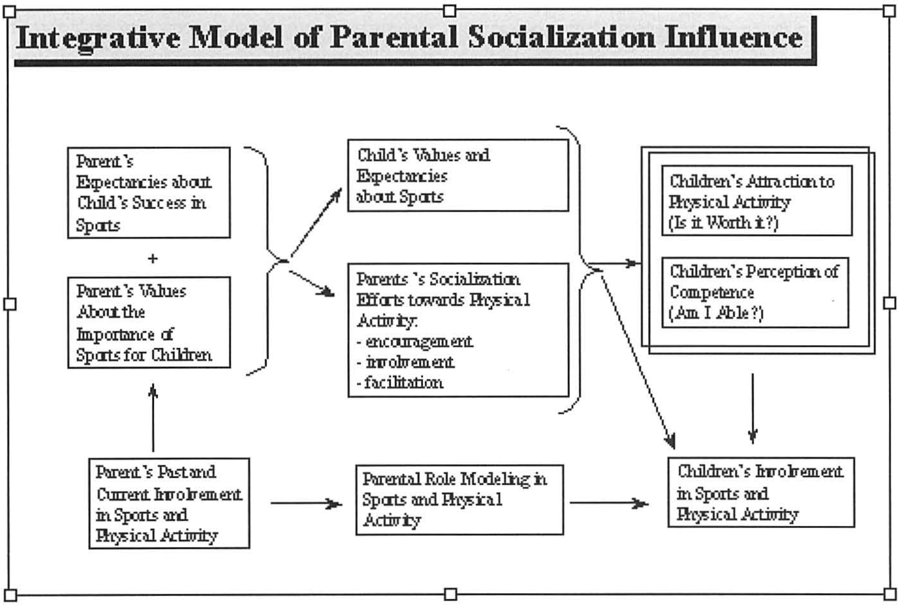

Figure 2. Integrative Model of Parental Socialization Influence

APPLICATION OF COMPETENCE MOTIVATION THEORY

Information and feedback that helps a child to build high perceptions of competence should be provided in order to enhance the child's interest and involvement in sport. Perceptions of competence are the central determinant of interest and involvement but the nature and source for establishing this self-assessment change over time. Children clearly depend on their parents for the initial interpretations of their experiences. It is these interpretations which are relayed to the child and impact their self-perceptions. With regular encouragement and support, children remain intrinsically motivated and can make a normal shift from external information to internal information on which to base their self-perceptions. How a parent responds to the initial mastery experience can influences how competent the child feels in that particular setting and shape their emerging self-perceptions. An example of two different parent-child interactions is provided below for illustration purposes.

Sarah is a third grader and decides to play basketball. The following two scenarios illustrate how the same event could have different consequences and effects depending on the type of parent-child interactions.

Scenario 1: During the first game her parents are watching, cheering, and smiling. When the game is finished her mother says to her "Sarah you did a great job out there. We sure enjoyed watching you play." Her father greets her with a hug and says, "That's my girl. Did you have fun? Maybe we could get a hoop at home and play together." The support and encouragement that her parents showed sends her the message that they think she is competent and has a natural ability for playing basketball. It also shows her that they are interested in her activities.

Scenario 2: During Sarah's first basketball game, Sarah's parents spend the entire game reading the paper and discussing the weekend plans. When the game is finished Sarah's mom says, "Come on Sarah. We have to go. We have groceries to get and now you have to have a bath before bed too." The dad walks over and picks up her jacket and says, "I am not sure I saw you dribble or make a good shot the entire game. Are you afraid to get in there and get tough?" In this situation, support or encouragement are lacking; the mom is hurrying off to the grocery store and the dad thinks she is not tough enough to be a basketball player. This tells Sarah that she lacks ability, or is not competent, in basketball and that her parents are not interested.

APPLICATION OF ACHIEVEMENT GOAL ORIENTATION THEORY

According to goal orientation theory, emphasis should be placed on fostering a task goal orientation towards sports and physical activity. Sport activities in western society, however, clearly lend themselves to an ego orientation. Sports generally include achievement situations in which there is formal evaluation and the outcome is generally of importance to parents. Children are also stratified by ability in most sports and their perception of ability is frequently tied to a normative (peer) comparison. To counter this potential for ego orientation, it is important to establish an environment and climate in which children experience sport from a mastery or task orientation. Emphasis should be placed on personal improvement and effort. Success then becomes associated with learning, effort, and personal improvement as opposed to winning or beating a particular team. With this orientation, success becomes something they can control, enjoy and expect because it has only to do with them and does not involve the evaluation and control of someone else's performance. Parents, often without realizing, reveal their orientation to the child by the questions they ask or the information that they seek. Examples of two interactions are provided below for illustration purposes.

Background: John comes home from a soccer game and his parents ask him a few questions about the game after dinner.

Scenario 1: The first question the parent asks is, "Did you win?" This shows that the parent is mainly interested in the outcome of the game and not what happened within the game. John learns that this is the important result and begins to adopt an ego-oriented focus with his involvement in sports.

Scenario 2: The first question the parent asks is "How did you play?" "Did you get a chance to head the ball? How did that go?" In this scenario, the parent is interested in the child's ability to improve their skills (to head the ball) and improve their game as a whole. The child focuses on how it felt to participate in the game rather than the outcome of the game. This helps the child adopt a task-orientation in sports.

APPLICATION OF ATTRIBUTION THEORY

Attribution theory suggests that feedback should help children to focus on effort (unstable) as opposed to ability (stable) when taking responsibility for a failure. The long-term consequences of attributing a loss to ability is that failing players consider themselves to be low in ability and therefore see little hope for future success. This can result in the athlete exhibiting "learnedhelplessness", in which the success is viewed as out of their control. Athletes in this state view their efforts as irrelevant; they may give up easily or drop out of the sport all together. Fortunately, it has been shown that, with the help of parents and coaches, athletes can adjust their thinking to associate a failing situation with effort and not ability.

Too often, children are taught to take responsibility for the outcomes (whether they are good or bad) and the child comes to believe that they can always change and impact the outcome. Attributions are created most typically in novel situations or situations with unexpected rather than expected events. Once there are previous experiences to look back to, the attributions are typically made based on previous determinations. Parents and coaches play a critical role in helping children to interpret new experiences with the appropriate orientation. They can clearly help a child learn when the outcome was in their control. It is what parents say and do immediately following a loss that may have a great impact on how the child attributes and explains the loss. An example of the application of attribution theory is provided below.

Volleyball is being offered as a new junior varsity sport. Kelly decides to tryout. After making the team, the team loses their first two games.

Scenario 1: After the second loss, Kelly's parents explain, "If you could get to the ball more quickly and actually get into the air to get the ball over the net, your team would have won both games but you just don't have the speed, lower body strength or height to play close to the net. Kelly concludes that she does not have the ability to play volleyball and there is nothing she can do about her performance or the outcome of the game.

Scenario 2: After the second loss, Kelly's parent's explain, "It is just a matter of hustle. You are a new team learning to work together and if you, as well as the rest of the team, could work more quickly to get into position and begin to understand what the other team members are doing you will begin to win games." Kelly has learned that she has some control over this situation and the outcome of the game can be changed with a little hard work.

5. SUMMARY

The social nature of competitive sport and the emphasis placed on achievement in society make the relationship between parents and their children a critical element in the healthy development of young athletes today.

Although further research on the nature and impact of various forms of parental influence is needed, a solid knowledge base exists to help mothers and fathers positively impact children's sport endeavors. What parents expect, the pressure they exert, the beliefs they maintain, the way they respond to performance, and the behaviors they engage in affect the lives of young sports participants. This information should be used to construct youth sport environments and experiences that enhance children's overall sport experience. New challenges for researchers are to examine the dynamic nature of parent-child interactions in the sport arena so that practitioners can continue to use this information more effectively.

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THE ROLE OF PARENTAL SUPPORT IN SPORTS SUCCESS OF TALENTED YOUNG DUTCH ATHLETES

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1. INTRODUCTION

Until the middle of the 20th century, it was possible to become an international athlete without belonging to a nation's group of most-talented individuals (Bouchard *et al.*, 1997). The selection process was less stringent and the level of competition was not as demanding as it is today. As a result of the growing importance of sports success in society, the continuous increase in the number of young athletes and the growing sophistication of training, psychological preparation, equipment and facilities, the level of competition has increased to the point that only the extremely gifted are potentially able to reach elite status. Talented athletes often begin intensive and time-consuming training at increasingly younger ages (Alabin *et al.*, 1980; Hahn, 1990). When a young athlete choses to develop his/her talent in order to reach elite status, this has major consequences for lifestyle. The process is long, averaging at least 10 to 12 years, and during this interval, significant others, particularly parents, play an important role.

Behavior of parents can have a positive effect on the sport behaviors of their children (Visscher *et al.*, 1996a). Family environment is an important factor in the development of talented young athletes (Ericsson, 1996), parental modeling is an important influence on children's acquisition of positive values, attitudes and behaviors toward sports and physical activity (Côté, 1999). According to Giljam (1988), however, there is a distinction in parental support between serving as a role model and giving stimulation towards athletic involvement and success in sports.

The present study attempts compares the parental support given by parents of more successful and less successful talented athletes. All athletes were originally designated as exceptionally talented, and the differentiation between them in terms of degrees of success occurred across time. The study addressed two questions:

- Do parents of more successful athletes provide a better role model for their child's achievements in sports than parents of less successful athletes?

- Do parents of more successful athletes stimulate their child more towards better achievements in sports than parents of less successful athletes?

2. THEORETICAL CONSIDERATIONS

Bouchard *et al.* (1997) described the elite athlete as an individual with a sports-specific profile in terms of morphological, physiological, metabolic, motor, perceptual, psychological and biomechanical determinants. The elite athlete is also highly responsive to regular training and practice. Bloom (1985) stressed the role of the family by indicating that the development of exceptional talents requires family support, excellent teaching and appropriate motivational reinforcement at any stage of their development. Regardless of the quality of their initial talent, each of the individuals in Bloom's study went through many years of development and training under the care of attentive parents and the tutelage and supervision of several teachers and coaches. All of the talented individuals interviewed in the study invested a substantial amount of time on practice and training, which clearly competed with time devoted to school and other activities. They indicated that the time invested in athletic performance was far more rewarding than that allocated to other activities. Athletic involvement was seen as a career, i.e., as a process with a beginning, a developmental trajectory, and an end.

Côté (1999) discussed the importance of parental influence on children's involvement and achievement in sports and other domains. Several authors (e.g., Bloom, 1985; Brustad, 1993; Hellstedt, 1987, 1995; Woolger and Power, 1993) have demonstrated that greater parental encouragement is associated with greater perceived physical competence in children. Parents of committed athletes are usually willing and happy to attend their children's competitions and tournaments, and are often present during practice sessions (Csikszentmihalyi *et al.*, 1993; Monsaas, 1985; Sloan, 1985). There is a positive relationship between parental expectations and children's success and enjoyment of sports (McElroy and Kirkendall, 1980; Scanlan and Lewthwaite, 1985). Other studies, however, have shown that parental expectations may be a source of pressure and stress that can interfere with their children's participation in sports (Brustad, 1988; Scanlan *et al.*, 1991; Visscher *et al.*, 2003; Weiss *et al.*, 1989), and that the relationship between parental expectations and children's enthusiasm may be curvilinear in some sports (Power and Woolger, 1994). Excessively high or low parental expectations are associated with less enthusiasm, while an intermediate level of expectation is associated with enthusiasm for swimming.

Although coaches have the most direct contact with children within the sports environment, parents are instrumental in determining children's sport involvement (Lewko and Greendorfer, 1988; McPherson and Brown, 1988). The "athletic triangle", i.e., coach, athlete and parent, is a natural feature of youth sports, and the role of the coach in relation to the parents is crucial for the success of a training program. Through their cooperative efforts, many parents contribute productively. Unfortunately, the negative impact of some parents is all too obvious. Some parents can undermine the basic goals of youth sport programs and deny youngsters of benefits that can be derived from participation. Most of the negative consequences in youth sports occur when adults erroneously impose a professional model on what should be a recreational and educational experience for children.

When excessive emphasis is placed on winning, it is easy to lose sight of the needs and interests of the young athlete. Hellstedt (1987) described parents' involvement in their children's sports career on a continuum from under-involved to moderately involved to over-involved. The moderate level of involvement describes parents who promote the best interests of their children, even if it means sacrificing personal interests. Bloom (1985) underscores the major influence of the family at different stages of talent development in science, art and sport, reporting that in the early years of children's involvement in one of these activities, parents tend to be supportive, allowing them freedom to decide whether to practice or not. This is followed by a period of dedication for both performers and parents. The later years are characterized by the individuals' full-time commitment to improving performance and the parents' role is more restricted, consisting mainly of financial support. Blooms' study thus provides a developmental perspective for the influence of family on talent development.

The early stages of the careers of international athletes have been considered from an interactionistic perspective by Stevenson (1990). Socialization has been explained as a process of "identity formation" (Lauer and Handel, 1983). The person is seen as an active and self-reflective participant in this process. The process is concerned with the ongoing development and support of specific role identities that the athlete perceives to be desirable and valued (McCall and Simmons, 1978).

The influence of parents on the achievement of talented young athletes is thus obvious. There is a distinction, however, in parental support as a role model and as a stimulant for athletic involvement. Butcher (1985) suggests that a combination of the two has the best effect on involvement and success in sports. Giljam (1988) adds that parents should create those opportunities for their children that are necessary in order for them to have a successful athletic career.

3. RESEARCH IN TALENTED DUTCH CHILDREN

3.1. Definitions

Parents serve as positive role models if they themselves are presently active in sports and/or have been in the past. Stimulation of athletic involvement can be divided into three components: financial support, emotional support, and success in sports. Financial support relates to the costs incurred for the sake of a child's sport career. Parents also play an important role in providing emotional support. Emotional support is viewed as consisting of three parts: presence at training, competitions and tournaments; contact with the coach; and whether or not parents attach importance to there being a pleasant atmosphere in their child's sport team (Visscher *et al.*, 1996b). The importance of success in sports is measured in two parts: the amount of pressure exerted on achievement and the value given to the social status parents can attain by way of their child's achievements in sports (Hahn, 1988).

3.2. Participants

In the Netherlands, talented young athletes are chosen to be part of a district selection team to develop their sport qualities with goal of competing at the national level. There are specific selections for individual and team sports. In the 14-16 year age group, there were 360 talented athletes who were members of the selection for the Northern part of The Netherlands in one of several sports: soccer, volleyball, field hockey, tennis, speed skating and judo. All athletes were asked to participate in the study. A total of 254 (71%) did and completed a questionnaire. This group consisted of 136 males (54%) and 118 females (46%), and had an average age of 15 years and 1 month. The sample included 176 team athletes (69%) and 78 athletes in individual sports (31%).

Table 1. Number of participants by gender and type of sport.

Sports	Male	Female	Total
Team athletes:	93	83	176
Soccer	52	38	90
Volleyball	17	21	38
Field hockey	24	24	48
Individual athletes:	43	35	78
Tennis	12	7	19
Speed Skating	12	18	30
Judo	19	10	29
TOTAL	136	118	254

Two years later, when the athletes reached the age group of 16-18 years, the trainers of the district selection teams determined whether or not the initial sample of 254 athletes could still be considered as talented, i.e., as successful in their respective sports. Athletes were viewed as more successful when they still performed at the highest national level for their age. For team sport athletes, this was competition at the highest national level for their age, and for athletes in individual sports, success was viewed as qualification for the national championship. Information on performance was available for 228 athletes (90%), 141 (62%) performing at a high level (more successful) and 87 (38%) no longer performing at a high level (less successful).

3.3. Data collection and data analyses

A questionnaire, 'Parental Support in Sports,' was designed for the study (see appendix). Most questions were in closed format using 4 or 5 point Likert scales, but open questions were structured to obtain more in-depth information. Responses were compressed into three categories: "great parental support", "some parental support" and "no parental support". Data were reported as percentages.

Two years after the initial survey, trainers identified the athletes who were more and less successful in their respective sports. The trainers used a list with the names of all the athletes that participated in the study. The questionnaire responses of the more and less successful athletes were then compared:

All analyses have been done using SPSS/PC+. The variables measured with the questionnaire are on ordinal level and to make comparisons between both groups, we chose a non-parametric test (Huizingh, 1993; Stevens, 1996). This study deals with two independent groups – more successful and less successful athletes – and the test used to investigate significant differences is the Mann-Whitney test (also called Wilcoxon test). The level of significance (α) has been set at the 0.05 level.

4. RESULTS

4.1. On role models

Over 90% of the parents served as a role model at least in some way, and there was a significant difference between the more and less successful athletes ($p<0.05$). Parents of more successful athletes were presently or in the past more active in sports than parents of the less successful athletes. This implies that parents of more successful athletes served as better role models.

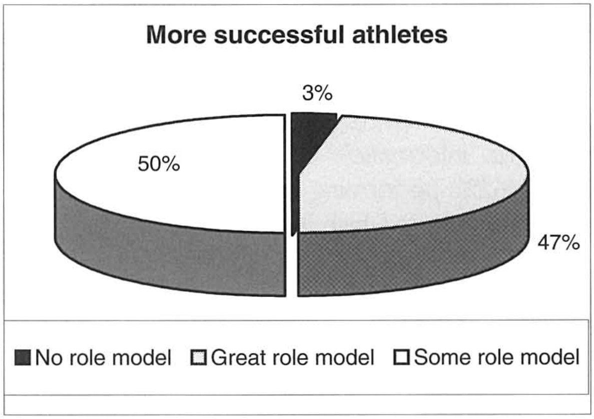

Figure 1a. Parental role modeling of youth athletes with high degree of success.

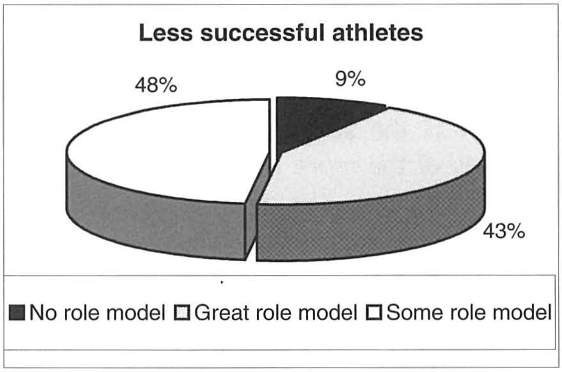

Figure 1b. Parental role modeling of youth athletes with low degree of success.

4.2. On stimulation

There was no difference between the two groups of athletes for financial support from parents. Parents of both the more successful and less successful athletes did not often discuss the costs that they incurred for their child's athletic career.

Over 75% of parents gave at least some emotional support, and the difference between more and less successful athletes was significant ($p<0.05$). The more successful athletes received more emotional support from their parents. Parental emotional support consisted of presence at training sessions, competitions and tournaments; contact between parents and coaches; and whether parents attached importance to there being a pleasant atmosphere for their child's sport training.

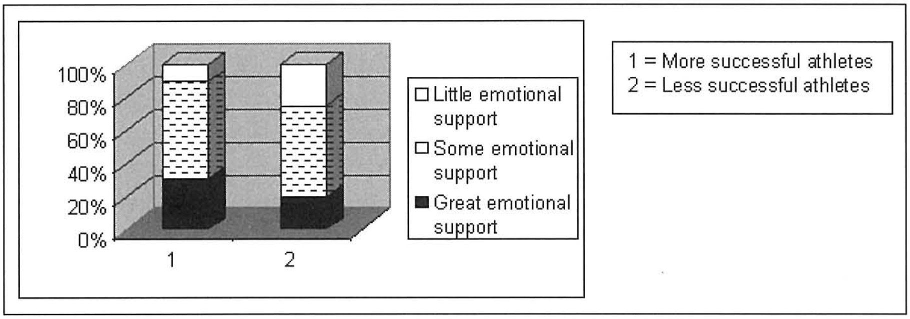

Figure 2. Parental emotional support of youth athletes with varying degrees of success.

There was no significant difference between the more and less successful athletes in the third component of stimulation, the"importance of success." At least 90% of all parents in both groups believed that their child's achievements in sports were important to very important.

5. DISCUSSION

All athletes were considered to be talented for their sport at the time the questionnaire was completed. After two years, some of the athletes were still viewed as talented, i.e. were still successful, while others were viewed as less successful. The more successful athletes still competed at the highest national level, while the less successful athletes no longer did so. Comparison of the two groups with regard to parental support for sport provides insights into family patterns that may be important for a successful athletic career.

It is clear that over 90% of all parents served as a role model for sport participation in some form and that over 75% of all parents gave at least some emotional support regarding the sports involvement of their child. The results indicate, in general, that families of talented athletes provide a very positive sports climate. The present study also showed differences in parental involvement between more and less successful athletes. Parents of more successful athletes provided better role models for their children's athletic achievements and more stimulation toward better sports achievements.

Only emotional support showed a significant difference between the two groups. As a trainer or coach, it is important to realize that parents of talented athletes play an important role during the development of a sport career. Without parental support, it is hardly possible for a child to reach elite status.

Bloom (1985) distinguished among the Early, Middle and Later years in the careers of talented individuals. The influence of the parents was greatest during the Early Years as they urged their child towards athletic activities. It was during the Middle Years that a young athlete was ordinarily identified as talented, and the nature of parental support was largely emotional and financial. Parental support became less important in the Later Years. although financial support did continue to play some role. Athletes in the present study can be placed in the Middle Years, so that it is not surprising that emotional support is of particularly great importance. In general, these athletes do not yet have a partner to turn to for emotional support, as is often the case in the Later Years, and this makes it a serious task for the parents.

As a trainer or coach, it is important to have regular contact with parents. By keeping parents updated about the training process and progress, parents are better informed and can provide appropriate support. It is also important to realize that parents attendance at training sessions, competitions or tournaments is generally a positive sign. Of course, negative concerns for over-involved parents should not be ignored.

Training methods and facilities are obviously important to provide athletes with the best opportunities to develop their talent. The atmosphere within the group is also equally important. Parents of more successful athletes in the Netherlands realize that a pleasant atmosphere is important for their child, and attach more value to this dimension of sport than parents of less successful athletes.

To develop a successful career in one of the sports included in this study (soccer, volleyball, field hockey, tennis, speed skating or judo), young athletes invest at least 8 to 10 years of training before reaching the top. This is only possible if the athletes enjoy the activities, since feelings of enjoyment are related to high intrinsic motivation (Biddle and Chatzisarantis, 1999). It is also suggested that acquisition of expert performance involves operating within three types of constraints, including a motivational constraint (Ericsson *et al.*, 1993). Trainers and coaches can contribute to the development of a successful sports career by, among other things, creating a pleasant atmosphere.

The differences observed between more and less successful athletes were already apparent when the total sample was still considered to be successful since they all competed at the highest national level for their age group and it was not yet apparent who would ultimately become more successful. Of course, there are many different variables that play important roles in the development of a successful sport career, including physical and mental qualities. It is also clear that parental support is important, since in most cases it is the parents who are part of the child's life during the course of the entire athletic career. Parents can serve as role models and can stimulate their child towards better achievements in sport and in school.

6. CONCLUSION

It can be concluded that both serving as a role model and providing emotional support are important to success in sport. There are differences between parents of athletes who are more and less successful over the long run, although it is not possible to affirm that parental support is the decisive factor.

The role of the parents in the sport involvement of talented youngsters is complex and the diversity of family contexts needs consideration (Côté,1999). The complete family environment needs consideration at each stage of a young athlete's development in order to understand the influence of parents and family dynamics on talent development.

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APPENDIX

Dimensions of the Questionnaire 'Parental Support in Sports', with questions, scales and guidelines for data analysis.

Parental Support in Sports

A. Role model

Was your father or your mother participating in sports in the past?

Yes, they both were	1
Yes, my father	2
Yes, my mother	3
No, they were not	4

Is your father or your mother currently participating in sports?

Yes, they both are	1
Yes, my father	2
Yes, my mother	3
No, they are not	4

B. Stimulation of athletic involvement

B.1. Financial support

Do your parents talk about the costs they have to make with regard to your involvement in sports?

Very often	1
Often	2
Sometimes	3
Hardly ever	4
Never	5

B.2. Emotional support

Do your parents (or one of your parents) attend your training?

No, never	5
No, hardly ever	4
Sometimes	3
Yes, often	2
Yes, very often	1

Do your parents (or one of your parents) attend your games/mathes/races?

No, never	5
No, hardly ever	4
Sometimes	3
Yes, often	2
Yes, very often	1

Do your parents talk with your trainer/coach about your sports involvement?

Yes, very often	1
Yes, often	2
Sometimes	3
No, hardly ever	4
No, never	5

Do your parents think it is important there being a pleasant atmosphere in your sport team?

No, not important at all	5
No, not so important	4
I don't know	3
Yes, important	2
Yes, very important	1

B.3. The importance of success in sports

Do your parents think it is important that you are performing at a high level in sports?

Yes, very important	1
Yes, important	2
I don't know	3
No, not so important	4
No, not important at all	5

Do your parents think it is important that you win a game/match/race?

Yes, very important	1
Yes, important	2
I don't know	3
No, not so important	4
No, not important at all	5

Do your parents think it is important that other people think highly of you because of your achievements in sports?

Yes, very important	1
Yes, important	2
I don't know	3
No, not so important	4
No, not important at all	5

Categories for role model:	
Great role model =	2-3
Some role model =	4-6
No role model =	7-8
Categories for financial support:	
Talk about the costs (very) often =	1-2
Talk about the costs sometimes =	3
Talk about the costs hardly ever or never =	4-5
Categories for emotional support:	
Great emotional support =	4-8
Some emotional support =	9-12
Little emotional support =	13-20
Categories for importance of success in sports:	
Great value =	3-8
Some value =	9-12
Little value =	13-15

Part 3:

GROWTH, MATURATION AND TRAINING

GROWTH AND MATURATION: BASIC PRINCIPLES AND EFFECTS OF TRAINING

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I. PRINCIPLES OF GROWTH, MATURATION, AND DEVELOPMENT

1.1. INTRODUCTION

The interval between birth and adulthood is commonly divided into age periods. The first year after birth (birth to the first birthday) is labeled infancy, which is followed by childhood. Childhood is usually subdivided into two phases, early and middle. The former approximates the "preschool" years, about 1 through 5 years of age. The latter approximates the "elementary school" years, about 5-6 through 10-11 years. The upper limit of middle childhood is arbitrary because it is followed by adolescence, which is variable in when it starts. Some fourth grade girls, for example, who are about 9-10 years of age, have already entered the early stages of adolescence. The termination of adolescence is also quite variable so that it is also difficult to specify when adulthood begins. Biologically, some girls are sexually mature by 12 years of age and some boys are sexually mature by 14 years of age; i.e., they are biologically adult. Yet, they are adolescents in the eyes of society. Adulthood is a socially defined concept, usually in the context of completing high school, and in some instances, completing college.

This chapter has several objectives:

- What are the basic principles of growth, maturation, and development?
- How do they interact during childhood and adolescence?
- What is the pattern of age changes and sex differences in growth, maturation, and development from childhood through adolescence?
- What is the pattern of change in the performance motor, strength and aerobic tasks from childhood through adolescence?

1.2. GROWTH, MATURATION, AND DEVELOPMENT

Children and adolescents experience three interacting processes: they grow, mature and develop (Table 1). These terms are often treated as having the same meaning. They are, however, three distinct tasks in the daily lives of children and adolescents for approximately the first two decades of life.

Growth

Growth refers to the increase in the size of the body as a whole and of its parts. Thus, as children grow, they become taller and heavier, they increase in lean and fat tissues, their organs increase in size, and so on. Heart volume and mass, for example, follow a growth pattern like that for body weight, while the lungs and lung functions grow proportionally to height. Different parts of the body grow at different rates and different times. This results in changes in body proportions - relationship of one part of the body to another. The legs, for example, grow faster than the trunk during childhood; hence, the child becomes relatively longer-legged for his or her height.

Table 1. Universal tasks of childhood and adolescence.

GROWTH:	MATURATION:	DEVELOPMENT:
Size	Skeletal	Cognitive
Proportions	Sexual	Emotional
Physique	Somatic	Social
Composition	Neuroendocrine	Motor
Systemic	Neuromuscular	Moral
	SELF-ESTEEM	
	BODY IMAGE	
	PERCEIVED COMPETENCE	

Adapted from Malina *et al.* (in press)

Maturation

Maturation refers to progress towards maturity or the biologically mature state. It is an operational concept because the mature state varies with body system. All tissues, organs, and systems of the body mature. Maturation is process which should be viewed in two contexts - timing and tempo. Timing refers to when specific maturational events occur, e.g., age at the beginning of breast development in girls, the age at the appearance of pubic hair in boys and girls, or the age at maximum growth during the adolescent growth spurt. Tempo refers to the rate at which maturation progresses, e.g., how quickly or slowly the youngster passes through the adolescent growth spurt. Timing and tempo vary considerably among individuals.

Development

Development refers to the acquisition of behavioral competence - the learning of appropriate behaviors expected by society. As children experience life at home, school, church, sports, recreation, and other community activities, they develop cognitively, socially, emotionally, morally, and so on. They are learning to behave in a culturally appropriate manner.

The three processes, growth, maturation and development, occur at the same time and interact. They interact to influence the child's self-concept, self-esteem, body image, and perceived competence. Teachers and coaches (note, coaching is teaching) should be aware of these interactions. A mismatch between the demands of a sport and those of normal growth and maturation may be a source of stress among young athletes. How a youngster is coping with his/her sexual maturation or adolescent growth spurt, for example, may influence his/her behaviors, including sport-related behaviors and performance.

1.3. GROWTH IN BODY SIZE AND COMPOSITION

Height and weight are the two body dimensions most commonly used to monitor the growth of children and adolescents. With age, children are expected to become taller and heavier. Size attained at a given age (status) and rate of growth (progress) are usually monitored relative to growth charts. These charts are a reference for comparison for monitoring the growth status (size attained) of individuals or samples of children and adolescents. Revised charts height, weight and the body mass index (BMI, see below) for American children from birth to 20 years of age were recently made available (Kuczmarski *et al.*, 2000). These are based on a nationally representative samples of American children and adolescents, and replace the earlier charts which were used internationally (Hamill *et al.*, 1979). The charts include several curves which indicate the distribution of heights and weights (percentiles) at a given age. For example, a child at the 25th percentile for height is taller than 25%, and is shorter than 75% of the children of the same age and sex.

Height and weight increase gradually during childhood. By about 9-10 years in girls and 11-12 years in boys, the rate of growth in height begins to increase. This marks the beginning of the adolescent growth spurt, a period of rapid growth that is highly variable among individuals. The rate of growth increases until it reaches a peak, which is called peak height velocity (PHV) or maximum growth in height during the adolescent spurt. Then it gradually decreases and growth in height eventually stops. Girls, on average, start their growth spurts, reach PHV, and stop growing about two years earlier than boys. Nevertheless, when the growth spurt starts, when PHV is reached, and when growth stops are very variable among individuals. Most other body dimensions follow a growth pattern similar to that for height and weight.

The growth spurt in body weight begins slightly later than that of height. Body weight is a composite measure of many body tissues, but it is often viewed in terms of its lean (fat-free) and fat components. Thus, body weight = fat-free mass (FFM) + fat mass (FM). Major components of FFM are skeletal muscle and bone mineral. FFM has a growth pattern like that for body weight and experiences a clear adolescent spurt. FM increases more gradually during childhood and adolescence. General guidelines for expected changes in height, weight, and body composition are summarized in Table 2.

Height and weight are frequently used in the form of the body mass index (BMI) – weight divided by height squared (kg/m^2). After an increase in infancy, the BMI declines through early childhood. It reaches its lowest point at about 5-6 years of age, and then increases with age through childhood and adolescence, and into adulthood. Sex differences in the BMI are small during childhood, arise during adolescence, and persist into adulthood. The rise in the BMI after the low point at about 5-6 years of age has been labeled the "adiposity rebound". It is suggested that children who have an early "rebound" have an increased probability of being overweight in late adolescence and young adulthood. This hypothesis, however, needs further confirmation.

An elevated BMI is generally accepted as an indicator of adiposity or fatness in public health and nutritional surveys. An international reference for the definition of overweight and obesity during childhood and adolescence has been recently developed (Cole *et al.*, 2000). These internatinally recommended age- and sex-specific cut-off points of the BMI for overweight and obesity between 2 and 18 years of age are based on pooled data from six nationally representative cross-sectional growth surveys – Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States. In establishing the cut-off points, a BMI of 25.0 kg/m^2 at 18 years of age was considered overweight and a BMI of 30.0 kg/m^2 at 18 years of age was considered obese. Curves were then mathematically fit to the pooled BMI data from 2 years of age on so that they passed through a BMI of 25 kg/m^2 and 30 kg/m^2 at 18 years of age (retro-fitting). The values at each half year from 2 to 18 years of age are the respective cut-off points for overweight and obesity.

The interpretation of the BMI in childhood, adolescence and young adulthood as an indicator of fatness needs care. An elevated BMI is not necessarily indicative of fatness during childhood and adolescence. The BMI is reasonably well correlated with total body fat and percentage fat in heterogeneous samples, but has limitations. Associations between BMI and fatness indicate a wide range of variability so that children with the same BMI can differ considerably in percentage fat and total fat mass, which emphasizes the need for care and sensitivity in the use and interpretation of the BMI as an indicator of fatness in individual children and adolescents.

Table 2. Guidelines for expected changes in height, weight, and body composition.

Pre-Adolescence or Pre-Puberty (about 6-10 years of age)

Children are expected to grow, i.e., increase in weight and height. Although there is much variation among individuals, children gain, on average, about 5-8 cm (2 to 3 inches) per year and about 2-3 kg (5 to 7 pounds) per year between 6 and 10 years of age. As adolescence and puberty begin, growth rates increase, first in height and then in weight.

Adolescence and Puberty

Adolescence is characterized by the growth spurt and sexual maturation. It is a time of considerable variation in when events occur and the rate at which children pass through them.

The following highlights general trends that characterize the growth spurt:

GIRLS
- begins around 9-10 years
- reaches maximum around 12 years
- rate slows after 12 years, but growth continues to about 16-18 years

BOYS
- begins around 11-12 years
- reaches maximum around 14 years
- rate slows after 14 years, but growth continues to about 18-20 years

Growth in height continues into the early 20s in some girls and boys

There is considerable variation among individuals in
TIMING - when the adolescent spurt occurs
TEMPO - rate of progress through the spurt

Body weight, FFM, and muscle mass also show adolescent spurts; they occur, on average, several months after the maximum rate of growth in height.

During the interval of maximum growth in height (about 11-13 years in girls and 13-15 years in boys), girls gain about 7 kg (15 pounds) in FFM while boys gain double this value, 14 kg (31 pounds); girls gain a bit more FM than boys during the interval of the growth spurt, 3 kg (6 pounds) versus 1.5 kg (3 pounds).

In a sense, during the growth spurt, "First you stretch them and then you fill them out!"

Adapted from Malina *et al.* (in press).

1.4. BIOLOGICAL MATURATION

The maturity status and progress of children and adolescents are ordinarily viewed two ways: skeletally and sexually. The timing of PHV is also an excellent maturity indicator, but longitudinal data are required to derive it.

Maturation of the skeleton focuses on the bones of the hand and wrist, which generally reflect the remainder of the skeleton. An x-ray of the hand and wrist is needed to assess skeletal maturation. As such, the method has limited utility outside of a clinical setting. It is, however, a valuable method that is useful throughout childhood and adolescence, and is also used along with height at a given age to predict adult height.

Sexual maturation is based on the development of the breasts and pubic hair in girls and the testes and pubic hair in boys. Assessment of sexual maturation is ordinarily done at clinical examination by a physician. Age at menarche, the first menstrual period, is the most commonly used indicator of sexual maturity in girls.

The two most obvious features of biological maturation during adolescence are puberty or sexual maturation, and the growth spurt (see above). The first physically apparent sign of sexual maturation in girls is usually the initial development of the breasts, followed by the appearance of pubic hair. The first overt sign of sexual maturation in boys, on average, is the initial enlargment of the testes, followed by the appearance of pubic hair. Each of these secondary sex characteristics goes through a series of changes as the individual passes through puberty to maturity. They are usually assessed by a physician at a clinical examination. Their assessment requires invasion of the youngster's privacy at a time of life when he/she is learning to cope with the physiological changes that are occurring during puberty. Monitoring of these characteristics requires utmost care and sensitivity to the youngster involved. Guidelines for normal variation in sexual maturation are outlined in Table 3.

Age at menarche is limited to girls since male puberty has no corresponding physiological event. Menarcheal status (i.e., has menarche occurred or not occurred) and age at menarche in individual girls can be obtained with a careful and sensitive interview. The average age at menarche in American girls is 12.8 years, although normal variation ranges from 9 through 17 years of age.

It is important that teachers and coaches are aware of such variation among individuals as well as the significance of sexual maturation for growth and behavioral development. Sexual maturation in boys is accompanied with marked gains in muscle mass and strength, and broadening of the shoulders relative to the hips. In girls, it is accompanied by smaller gains in muscle mass and strength, by a widening of the hips relative to the shoulders, and by gains in fatness. The net result is sex differences in strength, body build, and body composition in late adolescence and young adulthood. Sexual maturation also influences behavioral development, for example, increased self-consciousness, concern with weight gain in girls, relationships with the opposite sex, and so on.

Table 3. Guidelines for normal variation in sexual maturation.

GIRLS

- The first physically apparent sign of sexual maturation in girls is the initial enlargement of the breasts. It occurs, on average, at about 10 years of age, but may occur before 9 years in about 10% of girls and not until after 12 years in another 10%.
- Mature breast development occurs, on average, between 14 and 15 years of age. However, maturity may occur as early as 12 years in some girls and not until 16 or 17 years in others.
- Progress from initial to mature breast development is highly variable among girls. Some girls may pass through the process in 2 years, while others may take 5 or more years.
- Menarche, the first menstrual period, is a rather late maturational event of puberty. It ordinarily occurs after maximum growth in height (peak height velocity). The average age at menarche for American girls is 12.8 years.

BOYS

- Initial enlargement of the genitals (testes and penis) marks the first physically apparent sign of sexual maturation in boys. It occurs, on average, about 11 years of age, but may occur around 9 years in about 10% of the boys and not until after 13 years in another 10% of the boys.
- Mature genital development occurs, on average, at about 15 years of age. However, maturity may occur as early as 13 years and after 18 years.
- Progress from initial to mature genital development is highly variable among boys. Some boys may pass through the process in 2 years, while others may take about 5 or more years.

Adapted from Malina *et al.* (in press).

1.5. BEHAVIORAL DEVELOPMENT

Development of behavioral competence proceeds simultaneously in several domains - cognitive, social, emotional, moral, and motor. Motor development, i.e., the acquisition of motor competence, and motor performance are considered in a separate section.

Middle Childhood

The period between the preschool years and adolescence is often called middle childhood. It approximately spans entrance into school (first grade) to the onset of puberty (which, as indicated above, is variable in timing).

Competence gradually develops in many behavioral domains during middle childhood. However, two features are especially significant. First, the child gradually refines his/her self-concept: Who am I?, How do I feel about myself?, Where do I fit in?, and so on. Second, the child learns many skills, including cognitive skills - reading, writing, number manipulation and others, and interpersonal behaviors and relationships that underlie social, emotional and moral competence - sharing, cooperation, honesty, sensitivity to others, and so on. In the development of behavioral competence, the child often evaluates himself or herself. They very often ask questions about their identity and how others perceive them. Two primary sources of feedback in this self-evaluative process are adults, specifically parents, teachers and coaches, and peers (playmates and teammates). It is essential that adults who work with children be aware of their developing sense of self and the ongoing process of self-evaluation. Guidelines for the development of cognitive and social competence during middle childhood are summarized in Table 4.

Table 4. Guidelines for the development of cognitive and social competence during middle childhood.

5-8 years

Cognitive Competence

- Cognitive skills become elaborated as children show longer attention spans and increased problem solving ability.
- Children are able to handle multiple pieces of information; however, they have difficulty handling abstract or hypothetical questions.
- A major factor limiting the cognitive competence of young children is their lack of knowledge and experience using their developing skills.

Social Competence

- Children are expanding their understanding of self, i.e., self-concept formation.
- Children are interested in others, and often use other children as a reference of comparison in making self-evaluations and in defining themselves in terms of groups to which they belong.
- The peer group emerges as an important influence on children's behaviors. They are generally same-sex groups. Children have a strong sense of security in the group and in organized group activities.
- Given this sense of the group, children can learn a good deal from each other, which emphasizes the potential importance of cooperative learning environments.

9-12 years - transition from childhood to adolescence

Cognitive Competence

- Cognitive skills become more elaborated as children show longer attention spans and increased problem solving ability, and are able to handle multiple pieces of information.
- Logical thinking skills and hypothetico-deductive reasoning, and the ability to think about abstract concepts emerge during early adolescence.

Social Competence

- The strength of the peer group increases. The group is focal and is a means of establishing independence from adults.
- Individual differences in the onset of the growth spurt and puberty influence relationships with others and definition of the social self.
- A major social developmental task that emerges at this time is the formation of personal identity, i.e., accepting the self as worthy and different from others.
- There is a gradual shift from identifying with same sex peers to learning roles in heterosexual situations.

Adapted from Sproufe *et al.* (1992).

It is during middle childhood that the peer group emerges as a source of support, criticism, and comparison in handling the many challenges associated with an emerging sense of behavioral competence. Peer group activities occur in many settings and children have multiple peer groups, both formal as in school, church and organized sport, and informal as in neighborhoods and playgrounds. The significance and strength of peer groups increase with age during middle childhood.

The organized sport setting is a major source of peer group experiences for many children. In highly individual sports such as gymnastics, swimming, diving, figure skating and wrestling, coaches need to be especially sensitive to the child's need for group affiliation and the need to develop a sense of the group.

Table 5. Guidelines for the development of cognitive and social competence during adolescence.

Cognitive Competence

- Progress in logical thinking, hypothetico-deductive reasoning, and handling of abstract concepts continues.
- Enhanced abstract thinking is the basis for the ability for introspection. It is also the basis for emerging relationships between cognition and emotions.
- These cognitive skills expand the adolescent's ability to reason about moral and ethical issues.

Social Competence

- The formation of personal identity becomes crystallized, which contributes to establishing independence, i.e., the self as an independent person.
- The older adolescent's sense of self becomes more integrated, which contributes to better understanding of the uniqueness of each individual and to the ability to reconcile personal inconsistencies.
- Social relationships become more important. These contribute to self-evaluation and identify formation. Relationships with the opposite sex are especially important.
- There is increased acceptance of an adult role in different groups.

Adapted from Sproufe *et al.* (1992).

Adolescence

Adolescence, the transition from childhood to adulthood, is a period of major changes physically and behaviorally. The developmental tasks of adolescence are many, but three stand out. First, it is a period of physiological learning as the youngster copes with the physical and physiological changes associated with the growth spurt and sexual maturation. The youngster must learn to understand and accept the changes, to accept his/her body, and to adapt to masculine and feminine roles. A major concern of adolescents is their physical appearance. Second, it is a period of new relationships with age peers. During middle childhood, peer groups were largely same sex. During adolescence, youngsters develop relationships with age peers of both sexes, so that they have a major concern for social acceptance. And, third, it is a period of striving for independence. The youngsters strive for emotional independence from parents and other adults as they prepare for adult roles. Hence, it is a time of emotional peaks and valleys, of self-doubt, of changes in self-esteem, and of changing interests. Many youngsters experience a decline in self-esteem as they go through the developmental tasks of adolescence. It is no surprise that many youngsters drop out of sport between 12 and 14 years of age. The demands of normal adolescence may play a role in this decision. Guidelines for the development of cognitive and social competence during adolescence are outlined in Table 5.

Adolescence appears to be a drawn out process in some cultures, for example, the United States. It appears to be a time of confusion and insecurity for many youth as they strive for independence and adulthood.

1.6. PERFORMANCE

The development of proficiency in a variety of movement skills is a major developmental task of childhood and adolescence. Skillful performance, of course, is an important component of sports. During the preschool years and extending into middle childhood, children develop basic competence in fundamental movement patterns such as running, jumping, skipping, and so on. These movements are the foundation for other skills and sport-specific skills, and for physical activity in general.

Children commonly enter school or organized youth sports programs at 5 or 6 years of age, when many are still developing the basic movement patterns. One of the objectives of physical education and youth sports programs is to teach skills. Teachers and coaches of children entering school or a sport should have an understanding of the development of movement patterns and knowledge of how to provide an environment in which these patterns can be nurtured and improved. A primary responsibility of teachers and coaches is to guide the skill development process from basic patterns to skillful performance.

As basic movement patterns are refined through appropriate instruction and practice, performance quality improves and the basic patterns are integrated into more complex movement sequences and skills required for specific games and sports. The transition from basic movement patterns to more complex sports skills depends upon individual differences in neuromuscular maturation, earlier experiences and opportunity for movement, and the quality of instruction and practice. A proficiency barrier may exist for some children who do not have such opportunities for instruction and practice. A key person in this process is the teacher or coach, who should be able to meet the developmental needs of young children or sport participants though appropriate instructional sequences and guided practice opportunities. It is important for teachers and coaches to know how to observe the movements of a child. All too often, individuals tend to focus on the end product of a movement, e.g., whether the ball was struck or how far a ball was kicked. A teacher or coach should be able to analyze a movement to determine what are the important elements to observe. As a corrollary, the teacher or coach should have a sound knowledge of activities and experiences that will help the young athlete to progress in the development of a basic skill or a more specialized skill sequence. This way they will be able to know the process of what the child is doing rather than the result of what the child is doing. Knowing the process of performance is important to being able to provide corrective, positive instructional feedback to help improve performance.

The development of proficiency in basic movement patterns is accompanied by improved levels of performance which can usually be quantified. These are outcomes of the performance of tasks, e.g., the distance or height jumped (power), the distance and accuracy a ball is thrown (power and coordination), the time elapsed in completing a 30-yard dash (speed). Performances on such standardized tasks improve with age during childhood, and boys perform, on average, better than girls. There is considerable overlap between the sexes during early and middle childhood. With the onset of adolescence, the performances of boys show an acceleration whereas those of girls improve to about 13-15 years of age and then improve only slightly.

Tests of performance include anaerobic and aerobic components. Anaerobic power is the maximal ability to perform short-term (usually less than 30 seconds), high intensity bouts of exercise as in the vertical jump or a sprint. As such, anaerobic power follows a pattern of growth like that for sprints and jumps. Aerobic power is the maximal ability to uptake, deliver, and utilize oxygen to produce energy under aerobic conditions. It is an important determinant of endurance events. Absolute maximal aerobic power (expressed as liters of oxygen per minute) increases in boys and girls with age, and shows a clear adolescent spurt as do other performance tasks. When maximal aerobic power is adjusted for body weight, it shows little change with age in boys but declines with age in girls.

Performance during adolescence is influenced in part by individual differences in the timing of the adolescent growth spurt. Performances in a variety of tasks show well-defined adolescent spurts. Measures of strength tend show peak gains after the time of maximum growth in height (peak height velocity) in boys and girls. However, the magnitude of the growth spurt in strength is only about one-half of the maximum gain in boys. The same trend is apparent for power (vertical jump) in boys, but corresponding data are not available for girls. The trends for measures of strength and power are similar in timing to those for body mass and muscle mass, both of which experience their maximum growth after peak height velocity. Maximal aerobic power shows an adolescent spurt that occurs very close in time to that for height in boys and girls. When motor performances of girls are related to the time before and after menarche, there are no consistent trends. Menarche is a late maturational event during puberty, and major gains in growth and performance have already occurred.

The overall pattern of age- and sex-associated changes in a variety of performance tasks during childhood and adolescence is summarized in Table 6. The trends are based on group averages. Some girls, especially those active in sport, improve their performances through adolescence.

Table 6. Guidelines for the development of motor competence during childhood and adolescence.

5-8 years

- By these ages, the majority of children have developed the basic movement patterns. Note, however, that some children have not yet mastered the basic movement patterns at theses ages and would benefit from systematic instruction and practice under the supervision of qualified teachers/coaches.
- Performance in a variety of strength, speed, and power tasks improves more or less proportionally to gains in body size. Balance and coordination tasks also improve.

9-12 years - transition into adolescence

- Performances in motor (many are anaerobic), strength and endurance (aerobic) tasks, on average, improve with age.
- Individual differences in the timing and tempo of the growth spurt and sexual maturation exaggerate differences among children in performance. This is especially apparent among children of the same age who differ in maturity status.

13+ years -adolescence

- Performance in motor, strength, and aerobic tasks continues to improve, on average, in boys.
- On average, the performances of girls tend to reach a plateau at these ages or improve only slightly. In young female athletes who are systematically training for a sport, performances improve into late adolescence.

Adapted from Malina *et al.* (in press).

1.7. OVERVIEW AND IMPLICATIONS FOR TEACHING AND COACHING

For the sake of convenience, the preceding discussion arbitrarily partitioned childhood and adolescence into three periods that approximate childhood (5-8 years), the transition into puberty (9-13 years) and later adolescence (14-18 years). The first period represents the ages when the majority of children enter organized sports programs. The second period highlights the transition from childhood into adolescence which has major physical, physiological, and behavioral changes. It is also a period during which many youth drop out of sport programs, either by choice or by the more selective nature of many programs. The third period approximates the high school years, when sport programs are more selective and demanding.

It is important to note that the age ranges are arbitrary, especially between the second and third periods. These ages span the transition from childhood into adolescence, and the timing and tempo of the transition is variable within and among individuals. Thus, many of the cognitive and social developmental issues in the high school years are reworked in the context of those in the transitional period.

Variation within and between individuals in growth, maturation, and development is considerable. The marked changes in body composition are of specific concern, especially to adolescent girls and to many coaches. Motor performance may be influenced by an especially rapid growth spurt in both sexes. Relationships between peers may influence social behaviors and in turn relationships with coaches.

A teacher or coach should be able to apply these general concepts of growth, maturation and development to fit the needs of the young athletes in his/her program. Several suggestions for coaches in dealing with the physical, behavioral, and motor changes associated with the transition into and during the adolescent growth spurt and sexual maturation follow:

- Be aware of individual differences. As youth enter adolescence and during adolescence, they needs reassurance that they are "normal", i.e., not different from their peers. This need most often occurs in youngsters who are extremely early or extremely late in maturation. Above all, coaches should not make fun of them; peers often do, especially in locker rooms. The young adolescent is very sensitive to the growth and maturational changes that are occurring, and must learn to adjust to them. Adolescence is a period of physiological learning. The adolescent needs the support of understanding adults to transcend these changes with a positive view of self.
- Adolescents are very sensitive about their body weight and shape. Given changes that occur in body composition during later childhood and adolescence, teachers and coaches should avoid comments about body weight, especially in girls who in many cultures are being taught that "thin is in." Adolescent girls are very sensitive to weight changes associated with growth and maturation, and do not need to be reminded of them.
- Coaches should be careful in using body size as cut-points in sports. This especially affects late maturing youngsters who need to be given the

opportunity to participate and to keep working at improving skills, and who need to be reassured that they will eventually grow and mature.

- Coaches should pay attention to the child's eating behaviors and diet. A well-balanced diet is essential to support the needs of growth and maturation, in addition to those specific to physical activity and regular training for sport. Megavitamins are not a replacement for a well-balanced meal. Be aware of the use of antihistamines to suppress diet and of other ergogenic aids.
- Teachers and coaches should be aware of expected developmental changes and should also be aware of how developmental changes may influence performance. Some examples:
    - Since growth in height occurs before growth in body mass and strength, there may be temporary periods during which a boy or girl may appear to "outgrow his/her strength". The youngster needs reassurance that his/her strength will eventually catch-up.
    - There may be intervals during which a skill may temporarily decline compared to performances prior to the growth spurt, or there may be intervals during which skills may not improve as quickly. These may be associated with rapid changes in body proportions during the adolescent growth spurt, or changes in body composition associated with sexual maturation. The legs, for example, experience their grow spurt before the trunk does, which temporarily alters the position of the center of gravity.
    - Changes in body composition and development of the hips, particularly in girls, also may influence performance. The adolescent girl needs to be nurtured through these changes in a positive manner with appropriate instruction and practice in movement and sport-specific skills.

II. EFFECTS OF TRAINING ON GROWTH AND MATURATION

2.1. INTRODUCTION

- What are the trends in growth and maturation that characterize young athletes in several sports?
- What is the role of training for sport as factor that may influence growth and maturation?

It is often assumed that regular physical activity, including training for sport, is important to support normal growth and maturation. Just how much activity is needed is not known. Some have suggested that sport training has a positive influence on these processes, while others have suggested a potentially negative influence. Given questions raised by parents and at times the medical community, it is important that coaches be aware of the currently available information on the influence of regular training for sport on indicators of growth and maturation.

Young athletes in many sports have size, physique and functional characteristics that are similar to adult athletes in the respective sports. This would seem to emphasize an important position for growth and maturation in the processes through which children are selected or excluded from some sports.

This chapter first summarizes the body size, maturity status and functional capacities of young athletes in a variety of sports, and then discusses the potential role of training for sport as a factor influencing growth, maturation and function.

2.2. GROWTH AND MATURITY STATUS OF YOUNG ATHLETES

In order to evaluate the potential influence of training for sport on the growth and maturation, it is important to be familiar with the growth and maturity characteristics of young athletes. Some sports selectively choose or exclude youth on the basis of body size during childhood. The role of body size becomes more important in other sports later in childhood and during the transition into adolescence. At this time, size is closely related to the youngster's maturity. This section summarizes information on the heights, weights, and maturity of young athletes in a several of sports.

Size Attained

Average heights of athletes in different sports are expressed relative to percentiles of the growth charts for American boys and girls (Chapter 1) in Tables 2.1 and 2.2 for boys and girls, respectively. For example, male athletes in many sports have heights that fluctuate just above and below the median; this is indicated in the table as ±P50. If average heights are consistently above the median, this is indicated as >P50, and if average heights of athletes in a sport are consistently below the median, this is indicated as <P50.

Athletes of both sexes in most sports have, on average, heights that equal or exceed reference medians. Gymnastics is the only sport that consistently presents a profile of short height in both sexes. Most average heights of gymnasts are near P10. Figure skaters of both sexes also present shorter heights, on average, though data are less extensive than for gymnasts. Note that the trends are based on group means. However, given the wide range of normal variation among individuals and variation associated with individuals differences in biological maturation, there undoubtedly are exceptions to the trends suggested in the tables.

Table 2.1. Heights and weights of young male athletes relative to percentiles (P) of United States reference data.

Sport	Height	Weight
Basketball	P 50 - >P90	P 50 - >P90
Soccer	P 50±	P 50±
Ice Hockey	P 50±	P 50
Distance Runs	P 50±	≤P 50
Sprints	≥P 50	≥P 50
Swimming	P 50 - P 90	> P 50 - P 75
Diving	<P 50	≤P 50
Gymnastics	≤P 10 - P 25	≤P 10 - P 25
Tennis	P 50±	≥P 50
Figure Skating	P 10 - P 25	P 10 - P 25
Ballet	<P 50	P 10 - P 5

Adapted from Malina (1994. 1998) which contains the references for individual studies.

Table 2.2. Heights and weights of young female athletes relative to percentiles (P) of United States reference data.

Sport	Height	Weight
Basketball	P 75 - >P90	P 50 - P 75
Volleyball	P 75	P 50 - P 75
Soccer	P 50	P 50
Distance Runs	≥P 50	<P 50
Sprints	≥P 50	≤P 50
Swimming	P 50 - P 90	P 50 - P 75
Diving	≤P 50	P 50
Gymnastics	≤P 10 - <P 50	P 10 - <P 50
Tennis	>P 50	P 50±
Figure Skating	P 10 - <P 50	P 10 - <P 50
Ballet	≤P 50	P 10 - <P 50

Adapted from Malina (1994, 1998) which contains the references for individual studies.

Body weights present a similar pattern. Young athletes in most sports tend to have body weights that, on average, equal or exceed the reference medians. Gymnasts, figure skaters and ballet dancers of both sexes consistently show lighter body weight. Gymnasts and figure skaters have appropriate weight-for-height, while ballet dancers have low weight-for-height. A similar trend in indicated in female distance runners.

Body Composition of Young Athletes

Child and adolescent athletes have less relative fatness (% body fat) than non-athletes of the same age and sex. Male athletes and non-athletes both show a decline in % body fat during adolescence, but athletes have less relative fatness at most ages. Female athletes also have a lower % body fat less than non-athletes, especially during adolescence, and it appears that difference between female athletes and non-athletes is greater than the corresponding difference in males. Relative fatness, on the average, does not increase much with age during adolescence in female athletes, while it does in non-athletes. Although athletes tend to have less fat than non-athletes, there is variation among athletes and among different sports.

Maturity Status of Male Athletes

With few exceptions, male athletes in a variety of sports tend to be average (on time) or advanced (early) in biological maturation. Other than gymnasts, who show later skeletal maturation, there is a lack of late maturing boys who are successful in sport during early and mid- adolescence (about 12-15 years). However, late maturing boys are often successful in some sports in later adolescence (16-18 years), e.g., track and basketball, which emphasizes the catch-up in maturation and reduced significance of maturity-based differences in body size and performance of boys in late adolescence.

Maturity Status of Female Athletes

Most discussions of biological maturation of female athletes focus on the age at menarche, which is a late event during the adolescent growth spurt and puberty. Average ages at menarche in North American and European girls vary between 12.5 and 13.5 years, but the age range within which menarche may normally occur is 9 through 17 years.

Later average ages at menarche are often reported in athletes in many, but not all, sports. There is confusion about later ages at menarche in athletes, which is related, in part, to the fact that most of the information is based on recalled ages reported by college age and older athletes. The athletes are asked at interview or by questionnaire to recall when menarche occurred. Such data include potential error associated with accuracy of memory or recall.

When the distribution of recalled ages at menarche in large samples of athletes and non-athletes of the same chronological age and from similar social backgrounds are considered, there is considerable overlap between the samples. The distribution for athletes is simply shifted to the right, or later ages, by about one year or so. However, there are both early and late maturing athletes and non-athletes; it is just that there are more later maturing athletes than non-athletes.

Information on the age at menarche in adolescent athletes, i.e., teen-age athletes, is very limited. Presently available data are illustrated in Table 3. If an average of 13.0 years is accepted for North American and European girls, about 95% of girls will attain menarche between 11.0 and 15.0 years. Most samples of adolescent athletes have average ages at menarche within the range of normal variation. Only several samples of gymnasts and ballet dancers have average ages at menarche older than 15.0 years. Both of these activities have extremely selective criteria which tend to favor the late maturing girls.

Sample sizes in studies of adolescent athletes are generally small, and studies in which the athletes are followed from prepuberty through puberty are often limited to small, select samples. A potentially confounding issue in such studies is selective drop-out. For example, do earlier maturing girls selectively drop-out of gymnastics or figure skating? Or, do sports like gymnastics, figure skating and ballet select for late maturing girls, or do these sports systematically eliminate early maturing girls?

Table 3. Prospective and status quo ages at menarche (years) in samples of adolescent athletes (*1)

Athletes - Prospective		Athletes - Status quo	
Gymnasts, Polish	15.1±0.9	Gymnasts, world (*3)	15.6±2.1
Gymnasts, Swiss	14.5±1.2	Gymnasts, Hungarian	15.0±0.6
Gymnasts, Swedish	14.5±1.4	Figure skaters	14.2±0.5
Gymnasts, British (*2)	14.3±1.4	Swimmers, age group, U.S.	13.1±1.1
Swimmers, British	13.3±1.1	Swimmers, age group, U.S.	12.7±1.1
Tennis players, British	13.2±1.4	Divers, Junior Olympic, U.S.	13.6±1.1
Track, Polish	12.3±1.1	Ballet dancers, Yugoslavia	13.6
Rowers, Polish	12.7±0.9	Ballet dancers, Yugoslavia	14.1
Elite ballet dancers, U.S	15.4±1.9	Track, Hungarian	12.6
		Soccer players, age group, U.S	12.9±1.1
		Team sports, Hungarian	12.7

Adapted from Malina (1998a) which includes the references for specific studies, with the exception of figure skaters (Vadocz and Malina, under review). (*1) Prospective data report means, while status quo data report medians based on probit analysis. (*2) Among the British athletes, 13% had not yet attained menarche so that the estimated mean ages will be somewhat later. Small numbers of Swiss and Swedish gymnasts and ballet dancers also had not reached menarche at the time of the studies. (*3) This sample is from the 1987 world championships in Rotterdam. It did not include girls under 13 years of age so that the estimate may be biased towards an older age.

Performance Characteristics of Young Athletes

How do young athletes compare to non-athletes in motor performance? A priori, it might be assumed that athletes will perform better given the premium placed on skill and practice, and sport-related motor skills. However, data comparing the performances of athletes and non-athletes on standard tasks are quite limited.

Comparisons of athletes in several sports (divers, skiers, distance runners) and non-athletes can be made for two tasks commonly used in assessment batteries - vertical jump and sit and reach. Divers consistently exceed the values for non-athletes at all ages, while alpine skiers approximate the values for non-athletes. Distance runners are near the non-athletes until about 13 years of age and then lag behind. The trends for athletes in these three sports probably reflect the specific training demands of the respective sports. Diving places a premium on vertical jumping ability, while the other sports do not. Alpine skiing places more emphasis on side to side jumping, while distance running often focuses on endurance training to the neglect of explosive power. In contrast to the vertical jump, the young athletes have greater flexibility of the hamstrings/lower back. This trend probably reflects the emphasis on stretching as a preliminary to more specific training activities in a sport.

The limited data emphasize the need for further comparative research with young athletes. They also emphasize the specificity of training. Training programs emphasize the specific skills or demands of a sport. Other basic skills are perhaps taken for granted, or perhaps neglected. Early specialization and exclusive training in a specific sport may be an additional contributing factor.

Sex differences in motor performance for the general population of children and adolescents have been summarized in Chapter 1. A question of interest is the following: What is the magnitude of sex differences in the performances of elite young athletes within the same sport? Such data are not extensive, but suggest several interesting contrasts. Comparative data for elite female and male athletes in three sports - diving, downhill skiing and distance running, suggest the following. Sex differences in the performances of elite young athletes in the same sport are relatively minor until the male adolescent spurt. The male growth spurt in muscle mass, specifically upper body musculature, and in strength and power contributes to the sex difference in strength and power items at this time. In contrast, female athletes are more flexible than male athletes at all ages, and have a less intense adolescent spurt in strength and power.

Young athletes of both sexes differ from non-athletes in several physiological characteristics. Absolute and relative maximal aerobic power are greater in young athletes who train regularly in endurance sports such as swimming, running and cycling. The same is also true for soccer, which also has a major aerobic component. This is in keeping with the aerobic demands of these sports and the effects of regular aerobic training in contrast to limited aerobic training in such sports as baseball and American football. Since maximal aerobic power is related to body size, the differences in relative maximal aerobic power (per kg body weight) between athletes and non-athletes is more significant given variation in body size and maturity status among young athletes in many sports. The differences between athletes and non-athletes in relative maximal aerobic power tend to be small during childhood, but become progressively greater during adolescence, especially in males. This is related in part to the effects of regular training for several years and perhaps to a greater trainability of the oxygen delivery and utilization systems during male adolescence.

Comparisons of the aerobic power of young male and female athletes in the same sports indicate a relatively similar pattern of sex differences. Among young distance runners, sex differences in absolute maximal aerobic power (VO_2 peak) are small in late childhood and the transition into early adolescence (about 4-8%), but increase during adolescence so that the sex difference is about more than 20% between 15-17 years. When maximal aerobic power of the young runners is expressed per unit body weight, a similar pattern is apparent.

2.3. DOES REGULAR TRAINING FOR SPORT INFLUENCE GROWTH AND MATURATION?

Training refers to systematic, specialized practice for a specific sport or sport discipline for most of the year or to specific short-term experimental programs. Physical activity is not the same as regular training. Training programs are ordinarily specific (e.g., endurance running, strength training, sport skill training, etc.), and vary in intensity and duration. The quantification and specification of training programs by sport needs further attention.

2.3.1. Training and Growth in Height and Weight

Sport participation and training for sport have no apparent effect on growth in height (how tall a child is at a given age) and the rate of growth in height (how much a child grows in a year) in healthy, adequately nourished children and adolescents. The heights of young athletes probably reflect the size demands of specific sports. The smaller size of athletes in gymnastics and figure skating is evident long before any systematic training has started. Athletes in these two sports also have parents who are shorter than average, suggesting a familial contribution to their smaller size. Both sports also tend to selectively favor shorter participants.

Short term studies of athletes in several sports in which the same youngsters are followed on a regular basis over time, indicate rates of growth in height that closely approximate rates observed in the nonathlete children and adolescents. The growth rates are well within the range of normally expected variation among youth.

In contrast to height, body weight can be influenced by regular training for sport, resulting in changes in body composition. Training is associated with a decrease in fatness in both sexes and occasionally with an increase in fat-free mass, especially in boys. Changes in fatness depend on continued, regular activity or training (or caloric restriction, which often occurs in sports like gymnastics, ballet, figure skating and diving in girls and wrestling in boys) for their maintenance. When training is significantly reduced, fatness tends to accumulate. It is difficult to separate specific effects of training on fat-free mass from expected changes that occur with normal growth and sexual maturation during adolescence. This is especially so in boys because with the growth spurt and sexual maturation, boys almost double their estimated fat-free mass.

2.3.2. Training and Specific Tissues

Bone (skeletal), muscle and fat (adipose) tissues are three primary components of body composition. The skeleton is the framework of the body and the main reservoir of minerals. Skeletal muscle is the major work-producing and oxygen-consuming tissue, while adipose tissue represents energy in stored form.

a) Bone

Regular physical activity and training during childhood and adolescence are associated with increased bone mineral content and mass. The beneficial effects are more apparent in weight bearing (e.g., running, soccer, gymnastics) than non-weight bearing (e.g., swimming) activities. Of particular importance to physical activity and the integrity of skeletal tissue is the observation that bone mineral levels established during childhood and adolescence may be an important determinant of bone mineral status in adulthood.

In contrast to the positive influence of physical activity and training on bone mineralization, excessive training associated with changes in the menstrual cycle in some, but not all, post-menarcheal adolescent athletes may be potentially associated with loss of bone mineral if the alterations in menstrual function persist for some time. This is labeled as the "female athlete triad" - altered menstrual function, disordered eating and loss of bone mineral. Most of the data dealing with this issue are derived from adult athletes who have been intensively training in their given sport, usually distance running, for a long time. It should also be noted that variation in menstrual cycles after the onset of the first menstruation (menarche) in adolescent girls is the rule rather than the exception. It ordinarily takes about two to three years for menstrual cycles to become "regular". Coaches should not, therefore, be overly concerned about early "irregularity" in adolescent athletes. The adolescent girl needs assurance and understanding as she adjusts to the physiological changes of pubertal maturation.

b) Muscle

Information on skeletal muscle tissue is derived largely from short-term, specific training studies of small samples. Increase in muscle size (hypertrophy) is associated with heavy-resistance exercise programs, such as weight or strength training in adolescent boys, and may not occur or may occur to a much lesser extent in preadolescent boys and girls, and in other forms of training. There is no strong evidence to suggest that fiber type distribution in children and adolescents can be changed as a result of training.

Limited data for adolescent boys suggest that regular endurance training has the potential to modify the activities of oxidative enzymes (those involved in prolonged activities as in distance running). In contrast, regular sprint training has the potential to modify the activities of glycolytic enzymes (those involved in bursts of activity as in sprinting). The changes are specific to the nature of the training program, i.e., endurance or sprint. However, after cessation of training, enzyme levels return to pretraining levels, which indicates an important feature of training studies. Changes in response to short-term programs are generally not permanent and depend upon regular activity for their maintenance. An important question that needs further study is: How much activity is needed to maintain the beneficial changes associated with training?

c) Fat

In studies of children and youth, subcutaneous fat is most often measured in the form of skinfold thicknesses. Regularly active young athletes generally have thinner skinfold thicknesses compared to reference samples. It should be noted that individual skinfolds change differentially during growth, e.g., skinfolds on the extremities and not those on the trunk generally decline during adolescence in boys. Data for % body fat indicate similar trends - lower fatness in young athletes of both sexes than in non-athletes. As with skeletal muscle enzymes, regular training is necessary to maintain these beneficial effects on relative fatness. When training stops, relative fatness increases. Just how much physical activity or training is essential to modify skinfold thicknesses or maintain lower levels of fatness in growing children and adolescents is not known.

2.3.3. Training and Biological Maturation

Does regular training for and participation in sport influence the timing and tempo of biological maturation? As noted earlier, there is a wide range of normal variation among youth in the timing and tempo of biological maturation. It is a highly individual characteristic that often shows a tendency to run in families, i.e., mothers and their daughters may both be early or late maturers.

a) Skeletal maturation

Regular activity does not influence the rate of maturation of the skeleton. Short term longitudinal studies of boys and girls in several sports indicate similar gains in skeletal maturation in both athletes and non-athletes.

b) Somatic maturation

Regular training for sport does not influence the timing of maximum growth in height (age at peak height velocity) and growth rate in height (cm/yr or in/yr) during the adolescent spurt in boys and girls. It has been suggested that intensive training may delay the timing of the growth spurt and stunt the growth spurt in female gymnasts. These data are not sufficiently longitudinal to warrant such a conclusion. Many confounding factors are not considered, especially the rigorous selection criteria for gymnastics, marginal diets, and so on. Female gymnasts as a group show the growth and maturity characteristics of short normal, slow maturing children with short parents!

c) Sexual maturation

Longitudinal data on the sexual maturation of either girls or boys who are regularly active in and/or training for sport are not extensive. The limited longitudinal data indicate no effect of activity or training on the timing and progress of breast and pubic hair development in girls, genital and pubic hair development in boys.

Most discussions of the potential influence of training on sexual maturation focus on the later average ages at menarche which are often observed in females athletes in many, but not in all sports. Training for sport is indicated as the factor which is responsible for the later average ages at menarche, with the inference that training "delays" the onset of this maturational event. Unfortunately, studies of athletes ordinarily do not consider other factors which are known to influence menarche. For example, there is a familial tendency for later maturation in athletes. Mothers of ballet dancers, gymnasts, and athletes in several other sports attain menarche later than mothers of nonathletes, and sisters of elite swimmers and university athletes attain menarche later than average. The conclusions of two comprehensive discussions of exercise and reproductive health of adolescent girls and women are important to the present discussion:

> "although menarche occurs later in athletes than in nonathletes, it has yet to be shown that exercise delays menarche in anyone" (Loucks *et al.*, 1992, p. S288),

and,

> "the general consensus is that while menarche occurs later in athletes than in nonathletes, the relationship is not causal and is confounded by other factors" (Clapp and Little, 1995, pp. 2-3).

2.4. OVERVIEW

- Athletes of both sexes in most sports have, on average, heights and weights that equal or exceed reference values for the general population of children and adolescents.
- Gymnasts and figure skaters of both sexes present shorter heights, on average, but have appropriate weight-for-height. Female distance runners tend to show have low weight-for-height.
- Intensive training for sport has no negative effect on growth and maturation. In adequately nourished children and adolescents, growth in height and biological maturation are under genetic control.
- Regular training for sport has the potential to favorably influence body composition by increasing bone mineral and skeletal muscle, and decreasing fatness.
- In the few young athletes who present problems related to growth and maturation, factors other than physical training must be more closely scrutinized. In many cases of short stature, the shortness is largely familial, i.e., short children tend to have short parents. Shortness may also be related to late maturation, which may also be familial. In some sports, the growth of the young athletes may be compromised by marginal or poor nutritional status, and occasionally by eating disorders.

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RESPONSES OF CHILDREN AND ADOLESCENTS TO SYSTEMATIC TRAINING

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1. INTRODUCTION

Planned programs of instruction and training are basic to training for specific sports. Such programs have beneficial effects on several components important to athletic performance - motor skill, strength, and endurance. Evidence about specific training programs is often discussed in the context of the concept of the trainability, which refers to the responsiveness of children and adolescents at different stages of growth and maturation to an instructional or training program. This chapter first discusses the concept of trainability of children and adolescents, and then discusses the trainability of motor skill, muscular strength, and anaerobic and aerobic fitness.

- What is the concept of trainability?
- What are the responses of children and adolescents to training programs for motor skill, strength, and endurance.

2. CONCEPT OF TRAINABILITY

Trainability refers to the responsiveness of the individual to a specific training regimen. Trainability is related to the concepts of readiness and critical periods. It is often suggested, for example, that youth are more responsive to the beneficial effects of training during periods of rapid growth and maturation. The issue of trainability in the context of sport has been related primarily to the development of muscular strength and aerobic fitness, but it applies as well to the effects of instruction and practice on the development of motor skills, including sport specific skills. The term training, as used in this presentation, includes instruction and practice.

Discussions of trainability deal with two related, but different, questions: (1) What are the responses of children and adolescents to systematic training programs? (2) How responsive are children and adolescents to specific training programs? The first deals with the effects of training programs, whereas the second deals with the trainability of children and adolescents.

The sensitivity of growing and maturing individuals to training depends on a variety of factors including age; perhaps sex; growth and pubertal status; prior experiences; pretraining levels of skill and physical fitness (current status); psychological factors; and probably genetics. With the exception of several studies of responses of sedentary young adults to aerobic or strength training, the factors indicated above are not generally controlled in studies of children and adolescents. Quality of instruction in the training environment is an

3. TRAINABILITY OF MOTOR SKILLS

The nervous system is, to a large extent, near adult form, and most basic movement patterns are reasonably well established by 6 to 8 years of age, ages when many children have their first experiences in youth sports. It might be expected, therefore, that these ages would be ideal for specific instruction and practice in the basic motor skills.

Children 5-8 years of age are very responsive to systematic instructional and training programs for the development of movement skills. Planned instructional programs can enhance the development of basic motor skills in young children and more complex sports skills in older children. Guided instruction by qualified coaches, appropriate motor task sequences, and adequate time for practice are essential components of successful instructional programs at young ages. Since the skills utilized in most sports are combinations and modifications of the basic movement patterns, the importance of instruction and practice in organized sport during childhood is highlighted.

Instruction and practice in basic movement skills per se and in combinations or modifications of these skills in the requirements for specific sports are very important during late childhood and and the transition into adolescence. Youth 9-12 years are responsive to systematic instruction and training of specific motor skills, especially more complex sports skills, and to systematic, supervised strength training programs (see below). Specific instruction for girls should perhaps be emphasized early in this age range given the earlier transition of girls into the growth spurt and puberty.

At these ages, it may be difficult, however, to partition learning effects from those associated with growth and maturation. Motor performance improves more or less linearly with age during middle childhood. It continues to improve during adolescence in males, but tends to reach a plateau or to improve only slightly in females after 14-15 years.

4. TRAINABILITY OF MUSCULAR STRENGTH

Resistance exercise programs typically involve the use of weights or specially designed machines to provide the resistance against which a particular muscle group must work. Historically, resistance training for the development of strength was not recommended for prepubertal children (those who do not show the overt manifestations of puberty). This view suggests that prepubertal children are not as responsive to strength training as pubertal or postpubertal youth. Many studies in boys and girls 5-11 years, however, indicate that they respond to resistance training with gains in strength.

Although prepubertal children respond to resistance training with gains in muscular strength, they show no or only minimal muscular hypertrophy (increase in muscle size). The relatively small changes in muscle size compared to gains in strength suggest that the response to the resistance training stimulus in prepubertal children is largely changes in the nervous system. The nature of the responses is not known with certainty, but probably includes changes in the coordination of the nervous system.

Variation among individuals in response to strength training programs is not ordinarily considered or reported. Do all children respond in a similar manner? The answer is no. Are there an age-related effects on the response to training? Some data suggest smaller strength gains in absolute strength in younger children. Other questions that arise in discussions of strength training deal with possible differences in responses of boys and girls, and of chidren who vary in pubertal status. Although there is no sex difference among prepubertal children, the issue of sex differences has not received adequate study. Variation in response to training by pubertal status suggests greater percentage increases in strength by prepubertal boys, followed in order by pubertal and postpubertal boys has received some consideration. On the other hand, absolute strength is probably less trainable in prepubertal than in pubertal and postpubertal youth.

The preceding studies focus on resistance training designed to increase strength. Programs designed to improve muscular endurance also result in strength gains, but some evidence suggests that younger boys make greater relative gains in strength, whereas older boys make greater relative gains in muscular endurance. The results suggest differential responses to the type of training stimulus that depend upon age.

The persistence of strength gains in children and adolescents after the cessation of resistance training needs further study. Limited data for prepubertal children indicate that gains in strength associated with resistance training tend to revert to control values several weeks after the cessation of training. A related issue is the amount of training needed to maintain strength gains associated with training in children and adolescents. Presently available information on the training requirements for the maintenance of strength gains is not conclusive.

An issue of importance in strength training studies is the influence of the strength training on other aspects of performance. In other words, does strength training transfer to athletic performance? Data that address this question are limited.

In a study of girls 9-17 years of age, those who did isometric strength training also improved in the vertical jump and acceleration in sprint running, and girls who did vertical jump training also improved in isometric strength and acceleration in sprint running. Gains were greater in the domain that was specifically trained, i.e., girls who did isometric training made greater relative gains in isometric strength and girls who did vertical jump training made greater relative gains in the vertical jump.

Other data dealing with transfer of strength training to other aspects of performance are limited. A study of boys 6-11 years suggests improvements in the vertical jump and flexibility (sit and reach) after 14 weeks of resistance training, whereas a study of a combined sample of boys and girls 7-12 years suggests negligible changes in the vertical jump and the sit and reach after 8 weeks of training. The variable duration of the training programs may contribute to the different results. Further, it is difficult in both studies to partition the effects of the training program from expected changes in performance associated with normal growth.

5. TRAINABILITY OF ANAEROBIC FITNESS

Many youth sports are characterized by activities that involve short bursts that rely on anaerobic fitness. For example, a batter sprinting to first base, a running back dashing towards the goal line, or a soccer player running to a pass. Anaerobic fitness is influenced by growth and maturation, and possibly by specific anaerobic exercise training.

Information regarding the trainability of anaerobic fitness in children and adolescents is limited, and it is not clear whether anaerobic fitness is trainable in children and adolescents. Some studies, but not all, show greater anaerobic fitness in athletic youth compared to non-athletic youth. Experimental training studies suggest that anaerobic fitness can increased to some extent following a period of high-intensity training, but the data are limited to two studies of boys 10 to 13 years of age.

It appears that puberty is a critical period in the development of anaerobic fitness due to changes in body size, muscle mass, short-term ability of muscle to generate energy, and hormones associated with sexual maturation. Neural factors may also contribute to changes in anaerobic tasks associated with training.

There are moderately strong relationships between laboratory measures of anaerobic fitness and field performances. This suggests the potential for transfer of training-related improvements in anaerobic power to short-burst activities involved in many sports. Changes in anaerobic fitness with training are also probably related to improvements in the ability to resist fatigue during short-term, high-intensity intermittent bouts of activity such as repeated sprints.

6. TRAINABILITY OF AEROBIC FITNESS

The ability of the child or adolescent to perform under predominantly aerobic conditions is a major component of endurance performance. Aerobic power is the maximal amount of energy that can be transformed in the aerobic machinery of working muscle fibers per unit time (usually per minute). It is usually measured as maximal or peak oxygen consumption (VO_2 peak) as the youngster nears exhaustion while running on a motorized treadmill or cycling on a bicycle ergometer. It is quite difficult to obtain good measurements of aerobic power in children 10 years of age and younger.

A question of interest is the response of aerobic power to systematic endurance training, i.e., the trainability of VO_2 peak. Available data for short term experimental studies indicate relatively little trainability of maximal aerobic power in children under 10 years. Changes in VO_2 peak per unit body weight in children under 10 years with systematic training are generally small - less than 5%. It is not certain whether these results reflect low trainability of aerobic power or inadequacies of training programs. If it can be assumed that young children are habitually more physically active than adolescents and adults, a more intensive aerobic training program may be required to induce changes in maximal aerobic power.

Among older children and adolescents, responses of aerobic power to training improve. Youth training for a variety of sports usually have higher aerobic power, both in absolute terms (liters of oxygen per minute) and per unit body weight. In addition, individual differences in response to aerobic training are considerable. For example, among 35 boys and girls, 10.9 to 12.8 years, who participated in a 12 week aerobic training program, the average change in VO_2 peak per unit body weight was 6.5%. However, responses ranged from -2.4% to 19.7% of the young adolescents (Rowland and Boyajian, 1995). Thus, average values may be misleading.

The experimental studies of the effects of systematic endurance training are short term and ordinarily do not include a follow-up component. As a result, there is lack of information on the persistence of improvements in aerobic power after the cessation of training, and on the amount of training needed to maintain the improvements.

It is generally assumed that improvement in VO_2 peak will be associated with improved endurance performance. Running has received more attention than swimming in this regard. Among young distance runners, VO_2 peak is closely related to performance in the 1 to 3 mile run. However, improved running performance during childhood and adolescence is influenced by other factors besides of VO_2 peak. These include, for example, changes in body size associated with normal growth and maturation, running economy and anaerobic power.

6. OVERVIEW

- Motor skills in general and specific sport skills can be improved with systematic programs of instruction and practice.
- Prepubertal boys and girls respond to resistance training programs with gains in strength, but with minimal or no muscular hypertrophy. There is no sex difference in the response to resistance training among prepubertal children. The strength gains reflect changes in the nervous system.
- Regarding strength training for young prepubertal children, two different questions are usually asked as one: (1) How important is strength training for 8-9 year old children? - The answer is not known; motor skill training is probably more important. (2) Do 8-9 year old children respond to a strength training program? - Yes, with increased strength.
- Pubertal boys respond to resistance training programs with increases in strength and muscular hypertrophy. Increase in size of a muscle is a late training effect. The responses reflect neural and endocrine effects; the latter are associated with the growth spurt and sexual maturation.
- Pubertal girls also respond to resistance training programs with increases in strength, but with minimal hypertrophy. The latter reflects sex differences in hormonal changes during puberty.
- Data are less extensive for training programs that focus on muscular endurance. Limited data suggest that younger boys make greater relative gains in muscular strength, while older boys make greater gains in muscular endurance.
- Limited data suggest that anaerobic fitness can be improved following a period of high-intensity training. Anaerobic fitness increases considerably during puberty and the growth spurt due mainly to changes in body size

and muscle mass, and the capacity of muscle to generate short-term energy.

- Presently available data indicate relatively little trainability of maximal aerobic power (VO_2 peak) in children under 10 years of age. It is not known if these results are the consequences of low trainability (low adaptive potential to aerobic training) or to inadequacies of the training programs.

- Among older children in the transition into puberty/adolescence, and among adolescents, responses to aerobic training are enhanced. Responses are generally similar to those observed in young adults and sex differences are minimal. Studies are confounded by individual variation in the timing and tempo of the growth spurt and sexual maturation. In addition, maximal aerobic power shows its own well defined adolescent growth spurt.

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THE PHYSIOLOGICAL DEMANDS OF SOCCER: IMPLICATIONS FOR YOUTH TRAINING

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1. INTRODUCTION: AN ERGONOMICS PERSPECTIVE

A fundamental tenet of ergonomics is a focus on the human, whether male or female, young, adult or ageing. In the design of any activity, the tasks must be suited to the capability of the human. Such capabilities are limited, whether expressed in physical, physiological, psychological or perceptual motor terms. This notion of limited capacity is especially appropriate when youth soccer is concerned. The principle is that if the demands – of training or competitive match-play – exceed the individual's capacities, the result is excessive strain on that young person.

Sport does not necessarily comply with ergonomics principles since competition is associated with pushing back limits. Sports training theory relies on the principle of overload. The reasoning is that by imposing an overload on the organism, it gradually adapts to the training stress to reach a new level of performance capability. The athlete goes through a sequence of stages incorporating overload, recovery and adaptation in an upwardly spiralling cycle of improvement. Once the individual adapts to a new level of training stress, performance may attain a plateau so that the training stimulus must again be upgraded to induce further improvements.

This model of progressive overload becomes abstract when the individual fails to respond to training in the predicted way. Indeed performance may actually deteriorate even though the training stimulus is maintained. This phenomenon is known as 'overtraining' and sometimes referred to as 'over-reaching'. Repeated scientific attempts to identify biological predictors of this state have proved inconclusive. In the context of the young soccer player, an 'overtrained' state would be highly undesirable. Negative consequences include absence from participation whilst reaching recovery, associated 'burn-out' and a disaffection with playing the game.

The world of competitive sport differs from its occupational ergonomics counterpart in that the demands imposed during contests are unforgiving and cannot be adapted much by design intervention. Soccer is further complicated by the fact that success is determined by the sum of individual players' capabilities but by their harmonisation into an effective team unit. Nevertheless, individual profiles have implications for team selection and for interpreting fitness assessments, as is illustrated by Figure 1.

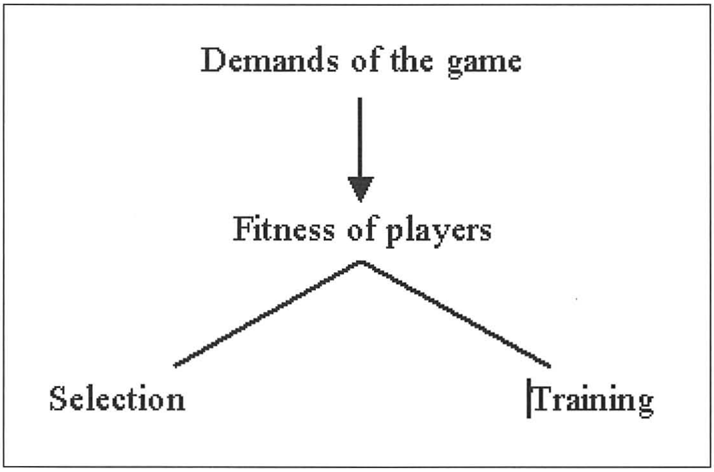

Figure 1. An ergonomics approach to analysing match demands.

In recreational soccer, particularly among youth players, the activity levels and physiological responses to play may reflect the demands which individuals are prepared to impose on themselves. For this reason the best insights into the specific stresses of soccer are evident when the game is played at the highest tempo possible. Examining the game at elite professional level provides useful scientific information about the unique physiological demand inherent in playing it.

A quasi-ergonomics approach is followed in this chapter. First, the demands of competitive soccer are covered with a view towards later outlining their implications for youth soccer. Further insights are provided by considering the fitness levels reached by elite players and their training programmes in order to prepare them for coping with the rigours of competition. Parallel studies are identified in young players as a check on the validity of the inferences for young players. Finally, there are consequences also for talent development and the necessity to be able to tolerate training over the period of developmental years.

2. PHYSIOLOGICAL RESPONSES TO MATCH-PLAY IN PROFSSEIONAL PLAYERS

The physiological demands of top-class soccer are quantified by measuring responses of players during match-play. More detailed invasive methods may be employed by halting play at pre-determined time-points or obtaining measurements at half-time and at the end of a game. The latter approach has been adopted when muscle biopsies have been obtained from players. Laboratory investigations have utilised intermittent exercise models that simulate the exercise intensity of competitive play and elicit physiological responses comparable to it (Drust *et al.*, 2000).

The energy expenditure during elite soccer match-play has been estimated to be about 5700 kJ. This figure assumes the individual is male, weighs 75 kg and has a maximal oxygen uptake ($\dot{V}O_{2\,max}$) of 60 ml kg^{-1} min^{-1} (Reilly *et al.*, 2000a). This rate of energy expenditure represents a proportional utilisation of just above 70% $\dot{V}O_{2\,max}$.

The major metabolic pathway employed during soccer match-play is aerobic (Bangsbo, 1994). It is not surprising, therefore, that muscle glycogen depots are severely reduced at the end of a game. Whilst the active muscles are heavily reliant on carbohydrate stores in muscle and liver depots, fat is also mobilised during exercise as reflected in elevated concentrations of free fatty acids during the second half. It is likely also that there is some contribution from protein to metabolism but its magnitude is below 5% of the total energy expended (Wagenmakers *et al.*, 1989). It seems that metabolic responses to soccer match-play are broadly analogous to those experienced during endurance exercise such as distance running. The predominance of aerobic metabolism would suit young players since the development of the anaerobic system lags behind the aerobic system during adolescence (Borms, 1986).

Although match-play is dependent on the capability for sustaining a high average aerobic loading, crucial aspects of the game call for anaerobic efforts. On average, players must sprint all-out every 90s and produce high-intensity efforts every 30s. The relative contribution of anaerobic activity in youth matches may be less than in professional games because of the delayed development of anaerobic metabolic pathways in the former (Reilly and Stratton, 1995).

Nevertheless, anaerobic power is relevant to youth soccer. It is important in accelerating the body over short runs, in leaping to contest possession of the ball in the air and in executing tackles. Muscle strength is relevant to many aspects of the game, in challenging for possession, in kicking the ball and balancing the body. Flexibility in muscle groups of the lower limbs is important in reducing injury risk in adult players (Ekstrand, 1982) and is likely to be relevant also to youth soccer players.

The energy expenditure during match-play is dependent among other things on the total distance covered. Consequently the distance covered is a useful index of the work-rate or exercise intensity (Reilly, 1997). It has proved sensitive to the influence of styles of play on work-rate and the fall-off in performance towards the end of a full game due to fatigue. A consistent influence on work-rate is imposed by the positional role of the player. Midfield players display the highest overall work-rates whilst centre-backs rely on anaerobic efforts and unorthodox movements in backwards and sideways directions (Reilly, 1997). It may, therefore, be prudent for youth players not to specialise too early so they can gain experience of the activities associated with different positions on the field.

3. PHYSIOLOGICAL CAPABILITIES OF ADULT PLAYERS

Fitness profiles of top professional soccer players provide a testimony to the requirements for match-play. In view of the aerobic demands of the game, the oxygen transport system is deemed to be important for successful performance. Maximal aerobic power is reflected in the maximal oxygen uptake ($\dot{V}O_{2\,max}$) whilst aerobic capacity represents the highest fractional utilisation of $\dot{V}O_{2\,max}$ that can be sustained in prolonged exercise. A useful indicant of this capacity is the so-called 'anaerobic threshold' which is more amenable to training than is $\dot{V}O_{2\,max}$.

The importance of $\dot{V}O_{2\,max}$ was emphasised in the squad values reported for Hungarian teams by Apor (1988). There was a direct correlation between the average $\dot{V}O_{2\,max}$ of players and the team's finishing position in the national league. Mean values in contemporary top teams exceed 65 $ml.kg^{-1}.min^{-1}$, although there is variability due to positional role (Wisloff *et al.*, 1998). It is likely that there is a threshold value around 60 $ml.kg^{-1}.min^{-1}$, below which an individual player is unlikely to perform successfully in top-class contemporary soccer.

Youth players are still developing in body size and physiological function, and so data for the latter may need to be scaled appropriately in any interpretation of comparisons with adult values. Even so, observations for talented young elite players confirm the importance of aerobic power (Reilly *et al.*, 2000b) for participation at an high level. Nevertheless, the need for fitness over a range of measures was emphasised when elite young players, aged 16.2-16.6 years, were compared with an aged-matched sub-elite group (see Table 1). The former had the higher values for $\dot{V}O2\max$ but were leaner and faster also in sprinting over 5 m, 15 m and 30 m. Besides, the elite players were much the superior in an agility run and in vertical jumping.

Table 1. Physiological characteristics of elite and sub-elite soccer players (mean ± s). data are from Reilly *et al.* (2000a)

	Elite	*Sub-elite*
Speed		
5-m sprint (s)	*1.04 ± 0.03*	*1.07 ± 0.06*
15-m sprint (s)	*2.44 ± 0.07*	*2.56 ± 0.12*
25-m sprint (s)	*3.67 ± 0.13*	*3.79 ± 0.17*
30-m sprint (s)	*4.31 ± 0.14*	*4.46 ± 0.21*
Speed endurance		
$\dot{V}O2\max$ *(ml.kg⁻¹.min⁻¹)*	*59.0 ± 1.7*	*55.5 ± 3.8*
Mean time (s)	*6.42 ± 0.16*	*6.74 ± 0.29*
Fatigue index (s)	*0.25 ± 0.19*	*0.39 ± 0.37*
Speed endurance (s)	*6.24 ± 0.19*	*6.74 ± 0.31*
Power (SVJ, cm)	*55.80 ± 5.82*	*50.21 ± 7.58*
Agility performance (s)	*7.78 ± 0.18*	*9.53 ± 0.73*

Abbreviation: SVJ = standing vertical jump.

Observations on professional soccer players also underline the need for quickness over short distances to complement a good oxygen transport system. Strudwick *et al.* (2002) compared anthropometric and fitness profiles of elite players in soccer and in Gaelic football. The combined groups were described as lean and muscular with a reasonably high level of capability in all areas of physical performance. Intra-group variability among the soccer players was attributed to the specificity of positional roles. Whilst both groups displayed good average values for aerobic power, the soccer players were superior in anaerobic performance.

Top-class players adapt to the demands of the game and these adaptations are reflected in their fitness profiles. Players may not need to have an extraordinary capacity within any discrete area of physical performance but must possess a reasonably high level within all areas. Early profiling of youth players may help to identify particular areas of weakness or deficiency which can then be redeemed by appropriate training regimens.

To a very large extent the positional role of a player is related to the player's physiological capacities. This harmonisation is evidence of an ergonomics model being realised. For example, midfield players and full-backs tend to have the highest $\dot{V}O2\max$ values and perform best in intermittent exercise tests, but have the lowest muscle strength. Physiological variables are both influenced by genetics and amenable to training so that in my interpretation of fitness data on young players, their trainability should be considered.

4. TRAINING

Training sessions are part of the occupational demands on professional players, being a formal preparation for their public competitive engagements. For young players the training environment is recreational in nature but for talented players on systematised programmes their regimens form a preparation for achieving long-term career goals. Nevertheless, lessons for training of youth players may be drawn from observations on the demands of elite competition on one hand and on training responses of young players on the other.

Fatigue during competitive match-play is reflected in declining muscle glycogen stores, rising core body temperatures and hypohydration due to seating. Mental fatigue is evident in an increase in errors and faults in concentration and decision-making as the game nears its end. There is also a decrease in muscle strength, a factor which may predispose to injury. For all these reasons, it is inadvisable to allow fatigue to occur due to prolonged training sessions where youth players are concerned.

Reilly and Ball (1984) showed that training with the ball optimised the physiological training stimulus compared to running at the same pace but without the ball. Working with the ball provides the added benefit of practising soccer skills. This criterion means that specific training drills should be sought which maximise game-related activity whilst sustaining an acceptable training intensity. Consequently, small-sided games may have an advantage over 11-a-side training matches for youth players.

Platt *et al.* (2001) compared 3-a-side and 5-a-side matches among non-elite players aged 10-12 years. The size of the pitch was modified to suit the number of players involved. The 3 vs 3 condition was superior to 5 vs 5 in a number of respects. There were more bouts of high-intensity activity and fewer bouts of lower intensity in the former. There was more engagement with the ball and more tackles executed (see Figure 2). Furthermore, the mean heart rate was higher in 3 vs 3 (184 beat.min^{-1}) than in 5 vs 5 (172 beats.min^{-1}), the difference being sustained throughout the 15 min of play. These values equated to 88% and 82% of players' predicted maximum heart rate. It seems therefore that the 3 vs 3 small-sided games provided not only the best opportunity for game-related activity but also the better physiological training stimulus.

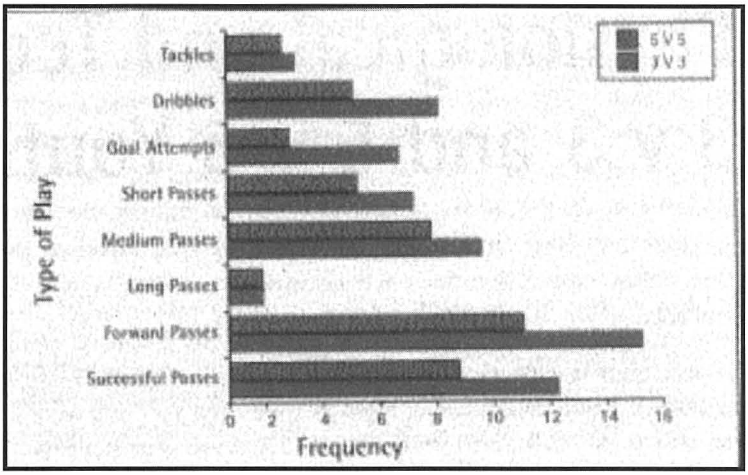

Figure 2. A comparison of player involvement during 5 vs 5 and 3 vs 3 games.

5. CIRCULATORY RESPONSE DURING CHILDREN'S SOCCER PLAY

Monitoring of heart rate permits a realistic assessment to be made of the circulatory strain during match-play. Drust and Reilly (1997) measured the heart rates of children aged 7-13 years playing 8-a-side matches, each for 10 min. The mean heart rates were 170 ± 18 beats.min^{-1} for the boys and 167 ± 20 beats.min^{-1} for the girls. Five players who participated in a further 10-min game immediately afterwards displayed mean heart rates of 179 ± 8 beats.min^{-1} and 181 ± 5 beats.min^{-1} for the 1st and 2nd halves of this extra match. These values are comparable to the 182 beats.min^{-1} in 5 vs 5 observed by Platt *et al.* (2001) over a 15-min match in 10 to 12-year olds.

Klimt *et al.* (1992) studied the physiological demands of matches in German players under 11 and under 12 years. Heart rates were in the range 160-180 beats.min^{-1}, values roughly comparable with those observed in adults. Blood lactate levels stayed in the range 3-4 mmol.l^{-1}, reflecting the completion of high-intensity efforts by children without major accumulation of lactate.

Seyers *et al.* (2002) considered whether late-maturing soccer players were at a physiological disadvantage compared to early maturers. They focused in particular on running economy in young players between 12 and 16 years of age. Running economy was assessed at three sub-maximal running intensities and allometric coefficients were used to take into account differences in body size. They were unable to find any physiological differences which could explain why the late maturers were able to keep up with the early maturers. Running style rather than age or maturation appeared to be the important determinant of running economy in these young soccer players.

6. TRAINING PRESCRIPTION FOR CHILDREN AND YOUTHS

It is inappropriate to extrapolate from data on professional players in prescribing training for children. Professional players have been estimated to expend 14.4 $MJ.day^{-1}$ on average while training (Reilly and Thomas, 1979). Such a training load would place inordinate demands on the daily energy requirements of young soccer players. Consequently, modifications are made for under-age matches and their programmes regulated accordingly. Furthermore, they are likely to pace themselves appropriately in open recreational play.

In the USA, matches at under-8 are divided into 4 quarters each of 12 min. At under-10 each half lasts 25 min, extended to 30 min at under-12 and 45 min at under-19. In tandem with these modifications are changes to the size of the pitch, the number of players and the regulations for substitutions. These rules are aimed at reducing the overall load on young players whilst allowing the game to retain its intermittent high-intensity nature.

Linquist and Bangsbo (1993) studied 112 young Danish soccer players aged 10-17 years with a view to establishing whether they need specific physical training. The young players performed soccer-specific field tests and their results were compared with those of adult players. The authors concluded that specific physical training should have a low priority until late puberty. They considered that the time could be better devoted to other types of training such as a focus on technical aspects.

A concern about possible injuries in young Japanese soccer players led Kohno and colleagues (1997) to study participants aged 12 to 18 years. The junior high school players (between 12 and 15 years) practised for 4.5 $h.week^{-1}$ on average, whilst the training of the senior high school players lasted 5.4 $h.week^{-1}$ on average. The authors monitored injuries, muscle strength and maximal oxygen uptake in each of the seven groups (i.e. ages 12 to 18 inclusive). They concluded that injuries could be decreased by taking changes in fitness levels of adolescent players into consideration when designing training programme for them. Their prescriptions were as follows:

- *From age 12 to 13 it is best to conduct technical exercises that do not overload the knee joint;*
- *at age 14, training may progress to improving muscle power (with appropriate loads) and sprinting;*
- *at age 16, endurance training may be introduced;*
- *training should be adjusted to different levels of fitness according to age.*

7. OVERVIEW

Observations on the physiological demands of competitive football provide insights into the physiological capabilities needed to cope with these demands. Such capabilities are multifactorial and can be enhanced by specific training. Allowance should be made for positional role and for the level of competition. Observations on young players demonstrate a capability to pace themselves appropriately for the shorter durations of matches. Young players should never be considered as miniature adults and during development a priority should be placed on skills acquisition, technical aspects and enjoyment of play. As talented players move into systematic training programmes to accelerate their development, they need to be able to tolerate high training loads. It is essential that in the process of optimising their development, the youngsters' capabilities are not overstretched.

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BILATERAL TRANSFER IN LEARNING: IMPLICATIONS FOR SPORT SKILLS

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1. INTRODUCTION

Methods to facilitate the learning of motor skills have been studied extensively by researchers in psychology and physical education. A major topic in this research is the concept of transfer, specifically inter-task, intra-task and bilateral transfer of skills (Magill, 1998). Bilateral transfer is the focus of this paper. Bilateral transfer of learning or training is the phenomenon of practising a novel task with one limb which then typically facilitates subsequent learning and performance by the opposite, untrained limb in the same task (Ammons, 1958). The terms cross-education (Parlow and Kinsbourne, 1989), intermanual transfer and bimanual skill transfer (Hicks *et al.*, 1982) are also used to define bilateral transfer.

Evidence for bilateral transfer dates to the late nineteenth and early twentieth century, but this type of research was quite popular from the 1930s through the 1950s. Although research interest the topic of bilateral transfer has not been as popular more recently, a reasonable amount of experimental data has accumulated over the past 50 years or so, addressing topics such as distribution of practicep, overload, response selection, and fatigue. Some research has addressed the underlying reasons or mechanisms for bilateral transfer and variation in the magnitude of transfer between limbs in learning and control of motor skills.

2. SIGNIFICANCE OF BILATERAL TRANSFER

Implications of bilateral transfer in the learning of sport skills are apparent in several contexts including the following:

(1) Bilateral transfer may result in the conservation of practice time;

(2) Practice of a skill on both sides of the body may lead to a more thorough understanding of the skill;

(3) The mechanism of bilateral transfer may shed light on whether and/or how transfer occurs in learning the complex movements

that characterize most sport skills, and whether and/or how transfer can be enhanced by practice and training;

(4) Understanding bilateral transfer in the learning of sport skills would enhance the effectiveness of teaching sport specific skills.

Overall,the study of the bilateral transfer may offer valuable insights into the understanding of skilled performance.

3. BILATERAL TRANSFER IN A VARIETY OF TASKS

Simple observation highlights the relevance of bilateral transfer. In the performance of both simple and complex motor tasks, most individuals express clear preference for one hand over the other, and about 90% of the human population uses the right hand for most skill activities (Hicks and Kinsbourne, 1976). A novel task practiced with one hand typically facilitates subsequent performance of the opposite, untrained hand in the same task. The same is suggested for transfer between the lower extremities. A question of interest is the following: Does bilateral transfer occur in the acquisition of more complex sport skills?

Early examples of research into the phenomenon of bilateral transfer include the following. Bryant (1892) noted transfer of tapping between two hands among the children during the development of voluntary motor ability. Woodworth (1899) studied bilateral asymmetry in manual aiming, and showed distinct superiority of the right over the left hand in accuracy. Swift (1903) was apparently the first to conduct an experiment on transfer with a ball skill. Subjects learned to toss two balls with a single hand (right), and then learned the same skill with the other (left) hand more quickly after mastering this skill with preferred hand (right). Subsequent research has generally focused on relatively discrete tasks including mirror drawing, tracing and writing; dart throwing; rotary and linear pursuit; pursuit tracking; inverted-reversed printing; one-hand typing and typewriting; rapid finger tapping; finger aiming and lifting; and a pegboard test (Ammons, 1958; Elliott *et al.*,1993). More complex movements studied in the context of bilateral transfer have included dance movements, knee extension, the basketball lay-up, the javelin throw and shotput, target throwing at target, and an anticipatory timing task (Ning, 2001; Teixeira, 2000).

4. WHY BILATERAL TRANSFER OCCURS?

It is apparent that much of the above literature on bilateral transfer is based upon discrete motor tasks, with relatively little applied to more complex tasks, including sport-specific skills. Clearly, many issues still need consideration, and among these is the explanation of the basis and/or underlying mechanisms of bilateral transfer: why transfer occurs, how it occurs, and the direction of transfer, among others. Two hypotheses, cognitive hypothesis and neuromuscular activation hypothesis, of why bilateral transfer occurs and threee models of how it occurs have been proposed.

Cognitive Hypothesis:

The cognitive hypothesis postulates that the common elements of a task to be performed by two limbs underlie the transfer phenomenon (Ammons, 1958). The hypothesis is based on the theory of identical elements proposed by Thorndike (1914). The essence of the identical elements theory is that in order for transfer of learning between skills and/or movement contexts to occur, the elements underlying the two skills or situations must be identical. A more recently developed view of transfer (Bransford *et al.*,1979), transfer-appropriate processing, proposes that the learning of any movement skill is enhanced if the nature of the processing activities involved in the practice of that skill is similar to the type of processing that underlies the performance of the same skill in a different context or in a different movement pattern from the one practiced. In contrast to the identical elements theory, advocates of transfer-appropriate processing suggest that is the similarity of the cognitive processing that determines whether transfer occurs (Ross, 1997). According to the transfer-appropriate processing framework, practicing a variety of structurally dissimilar skills that require the same types of cognitive processing needed to perform other related movement skills, should promote positive transfer (Lee, 1988).

The cognitive hypothesis suggests that bilateral transfer is a result of central information processing and does not entail peripheral neuromuscular transmissions. The role of mental imagery in bilateral transfer from the right to the left hand was investigated in a rotary pursuit task to address the issue of central processing (Kohl and Roenker, 1980, 1983). A sample of 60 right-handed males were randomly assigned to one of three groups: right hand mental imagery group in which the subjects created an mental image of himself holding the stylus in the right hand and performing the rotary pursuit; right hand physical rehearsal group in which the subjects physically practiced the pursuit task; and a control group without neither mental imagery nor physical practice. Results of left hand performance in rotary pursuit tracking of all subjects showed that mental imagery and physical rehearsal significantly facilitated bilateral transfer, i.e., transfer from the right to the left hands. The physical and mental imagery practice groups performed similarly and both performed better than the control group. The results suggest a cognitive basis for bilateral transfer.

Other studies suggested that bilateral transfer occurred in contralateral hand among subjects who only observed the other hand performing a task.

Moreover, the amount of bilateral transfer shown by the subjects who observed the task was as much as that which occurred among the subjects who physicall practiced the task. It has also been suggested that the knowledge architecture of a task needs to be first established and then gradually modified and refined as a skill is acquired (Glencross, 1992). Thus the initial stages of learning require the recognition and elaboration of the relevant declarative knowledge and the development of a knowledge structure. The role of initial instruction, demonstration and observation is critical in this process. The cognitive hypothesis thus involves a cognitive representation of the observed behavior that provides a standard of correctness and guides the subsequent action so that observation (e.g., verbal self-instruction) can lead to bilateral transfer in learning.

Neuromuscular Activation Hypothesis

Neuromuscular involvement in bilateral transfer has also been hypothesized. It has been proposed that some bilateral transfer of skill is mediated by inter-hemispheric transfer of the motor components of the task (Hicks, 1983). "Motor overflow at a submotor level" provides the nonpracticing limb with the kinesthetic sensation of moving without any overt movement. An overflow of impulses to the contralateral limb apparently occurs during practice. It was also suggested that involuntary movement (motor overflow) accompanying the intended movement might be related to the transfer of training. During the performance of rapid finger-sequencing by one hand (active hand), unintended movement (i.e., motor overflow) was observed in the passive hand (Edwards and Elliott, 1987).

A role for task efficiency in the occurrence of motor overflow has also been proposed. Within the framework of schema theory (Schmidt, 1999), this information can be used for error detection and correction, and can be integrated into the development of a generalized motor program for control of the movement. In essence, neural activity as evidenced by EMG readings in the nonpracticing limb facilitates the transfer of task-specific motor components between limbs and covertly promotes the development of a motor program to control the performance of the nonpracticing limb (Hicks, 1983). In a study of unilateral isometric training of the quadriceps, a large increase (576 to 793 Newtons). The contralateral (control) leg also increased (though not significantly) in isometric force (606 to 662 Newtons), suggesting a bilateral transfer of training effects (Rutherford and Jones, 1986).

Overview of Hypotheses

Bilateral transfer does occur and evidence for both neuromuscular activation and cognitive explanations has been reported. This would suggest that bilateral transfer is the result of both cognitive and motor factors. Two implications for the learning of sport skills follow. First, learning a sport skill has a cognitive base. Second, sport skills are controlled by a generalised motor program that represents the specific actions without including muscle information. Skill refinement including specific neuromuscular involvement follows with training.

4. HOW BILATERAL TRANSFER OCCURS?

It is generally that the direction of bilateral transfer is asymmetric, i.e., a greater amount of transfer occurs from one limb to the other. It is not clear, however, whether this asymmetry favours initial preferred or non-preferred limb practice, or whether transfer of learning is greater from the non-preferred to the preferred side, or vice versa. Taylor and Heilman (1980) showed that initial training with the non-preferred hand led to greater transfer to the preferred hand than the opposite practice and transfer schedule did while Parker-Taillon and Kerr (1989) proposed that initial practice with the preferred hand would provide better quality feedback with regard to response specifications and sensory consequences and thus transfer of learning should be greater from the preferred to the non-preferred hand. Three models of inter-hemispheric interaction have been proposed to explain the asymmetry of bilateral transfer.

Access Model:

Based on observations that the right hand benefited more than the left from opposite-hand training, an access (callosal) model has been suggested (Parker-Taillon and Kerr, 1989). The model links the direction of greater transfer with hemispheric specialisation for some tasks, specifically of the left hemisphere which controls movements of the right hand. The corpus callosum participates in such higher order "control" functions as the support of bilateral representation of language, functional inter-hemispheric inhibition, and the maintenance of hemispheric differences in arousal (Clarke and Zaidel, 1994). Further, callosal regions that connect primary and secondary sensory and motor areas are characterised by a large proportion of fast-conducting, large-diameter fibres, while regions connecting the association areas and prefrontal areas have a high density of slow-conducting, lightly myelinated and thin fibres (Aboitiz, 1992). These observations suggest that the fast-conducting fibres connecting sensory and motor areas contribute to fuse the two hemi-representations in each hemisphere. According to the access model, lateral transfer should favour the right hand (in right-handed subjects) because of direct access to skills learned by the left hand in the left hemisphere, and same hand training would be superior to opposite-hand training for the non-preferred but not for the preferred hand.

Proficiency Model:

Several studies of opposite hand training have shown that the left hand benefited more than the right hand in mirror-drawing, rotor pursuit and fast tapping. A prepropammed, nonsequential model of motor control associated with right hemisphere function was proposed (Parlow and Kinsbourne, 1989). The greater proficiency of the right hand for most unimanual skills was due either to left hemispheric specialisation and/or greater practice. This proficiency model argues that the more proficient hand (hemisphere) learns more elements during training and/or forms a better standard that then can be used to the advantage of the untrained hand. Although each hemisphere may be capable of performing a component of a given processing task, the stage of processing required to complete the operation is functionally localised to one hemisphere.

The proficiency model generates a contrasting prediction as does the access model, i.e., the left hand should benefit more than the right from opposite-hand training. The proficiency model proposes that same hand training is superior to opposite-hand training for the preferred hand, but not for the non-preferred hand.

Cross-activation Model:

The cross-activation model presents an alternative view. Accordingly, under certain conditions (as when the preferred hand is trained), dual "engrams" are formed - one in each hemisphere, and under other conditions (as when the non-preferred hand is trained), a single "engram" might be formed (Parlow and Kinsbourne, 1989). To explain why the former would facilitate the transfer of skill between limbs, it is speculated that activation of the dominant hemisphere leads to maintaining the opposing hemisphere in a state of readiness to respond. In this state, the nondominant hemisphere learns about the task in parallel fashion, forming an independent internal representation (engram) and interpreting the information obtained from the preferred hand in its own way. The cross-activation model assumes coupling of hemispheric proficiency in the sense that the dominant hemisphere is usually more efficient, which is reflected in better performance by the hand that it controls. Evidence for cross-activation comes from clinical studies of the corpus callosum. This brain structure apparently plays a role in bimanual motor co-ordination although other pathways (probably ipsilateral and/or subcortical) may provide compensation in cases in which the corpus callosum is absent. Clinical data also suggest that the corpus callosum may be important for inter-hemispheric transfer of tactuo-motor learning when a spatial component is involved (Sauerwein and Lassonde, 1994).

5. WHAT IS TRANFERRED BETWEEN THE LIMBS?

In general, bilateral transfer of learning is task-specific, and the main control components for proficient performance and control of action are transferred between the limbs. The main control components are both cognitive (or perceptual) and motor. Bilateral transfer may occur in different ways. There may be a transfer of all relevant components for proficient performance, or a transfer of only more generalizable, effector independent, control components. Transfer may be partial with a decline in performance of one or more components in the transfer task, or complete. Examples of transferable components in motor behaviour are anticipatory timing and force control (Teixeira, 2000).

Bilateral transfer occurs in both directions during the learning of a skill, i.e., from the preferred to the non-preferred limb and from the non-preferred to the preferred limb. This was shown for performance errors, velocity and acceleration in learning overarm throwing (Ning, 2001). However, performance errors (perceptual component) transferred more so from the non-preferred to the preferred hand, while velocity and acceleration (motor components) transferred more from the preferred to the non-preferred hand in this experiment with the overhand throw.

It is speculated that directional effects in the transfer of training between hands may be linked to brain organization, and specifically to hemispheric specialization of function. Hemispheric specialization of function indicates that the left hemisphere is specialized for speech and phonetic analysis, motor functions, and certain forms of emotion, while the right hemisphere is specialized for some visuo-spatial functions, components of attention, and other forms of emotion (Hoptman and Davidson, 1994). The right hemisphere may also have a special role to in preparing spatial aspects of aiming movements, while the left hemisphere is more important for movement execution (Elliott *et al.*, 1993).

The amount and direction of bilateral transfer of learning in motor skills are apparently dependent on the main components, or on a combined pattern of perceptual and motor components involved in a given task. There is variation, however, in the transfer of measures that are predominantly cognitive or perceptual in contrast to measures that are predominantly neuromuscular (kinetic or kinematic).

6. POTENTIAL IMPLICATIONS FOR SPORT SKILLS

- Bilateral transfer is asymmetric. Hence, sport skills which require both limbs to be involved, as some ball games, the preferred limb should learn and practice a complex sport skill to a reasonable degree of proficiency before practice for transfer to the non-preferred limb. For example, a basketball player may practice dribbling first with the right (preferred) hand; then after an amount of practice with the right hand, the player begins to practice dribbling with the left hand. Thus, the right hand not only has a greater amount of practice, but practice with the right hand will enhance the more efficient learning of by the left hand because bilateral transfer occurs between the two hands during learning.

- Alternative practice is optimal for the acquisition of bilateral tasks in contrast to practicing the task with the preferred or the non-preferred hand. The efficiency of an alternative schedule can be attributed to the involvement of both hemispheres and limbs in the practice. It is also suggested that alternative schedules should be used in learning of bilateral motor tasks in order to optimize the learning process.

- Both motor and cognitive elements could be transferred between limbs. The rationale and principles of bilateral transfer suggest that when the preferred limb is not able to perform because of injury, practice with the non-preferred limb may help to retain and perhaps enhance the athletic ability of the preferred limb. It is also possible than practice with the non-preferred may have a facilitatory in overcoming the deficits of the injured preferred limb. For example, in some sports (e.g., tennis, badminton) or events/activities within a sport (e.g., throwing), practice or special exercises with the non-preferred hand may help to avoid decrease in the capacity of the preferred arm and/or may maintain the capacity of the preferred hand. This may have relevance during the treatment and recovery phase of injured limbs.

- During training or the course of a season, performances of athletes occasionally stagnate and even decrease. This is commonly referred to as a "plateau" and "slump". This is likely due to inhibiting or restraining factors (both cognitive and motor). According to the rationale of bilateral transfer, practice with the non-preferred (non-dominant) limb may transfer to the preferred (dominant) limb which has been inhibited/restrained. When the effects of bilateral transfer are accumulated, the inhibiting/restraining factors on thepreferred/dominant limb may be relaxed or alleviated, so that the "plateau" or "slump" is overcome.

There are probably other implications and applications of the principles of bilateral transfer to sport skills, but these need to be elucidated in the contexts of specific age groups and sports. Unfortunately, a good deal of motor learning research is based in the laboratory and on adults so that application of these principles to the playing field or gymnasium, and to young athletes, many of whom are learning sport-specific skills, needs care.

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PROFILE OF YOUTH SOCCER PLAYERS: AGE-RELATED VARIATION AND STABILITY

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1. INTRODUCTION

Study of the structural and functional characteristics of athletes has a long tradition in physical education and the sport sciences (see Malina, 1997). For example, an extensive battery of anthropometric and functional characteristics was routinely collected on Harvard University students during the latter part of the 19^{th} century (Sargent, 1887). These early observations suggested that the development of athletes was governed, in part, by the constitution of the individual, the specific sport, and the time devoted to practice of the sport. Sargent asked many questions that are still relevant today. For example, can outstanding athletic ability be predicted from body structure?, or does the athlete have a physique that is best suited for a specific sport?

It is also increasingly apparent that elite young athletes often show the physical characteristics associated with successful adult athletes in specific sports (Carter and Heath, 1990). Such observations highlight the need to better understand the growth and maturation of young athletes in the context of the training programs to which they are exposed, often beginning at relatively young ages (Malina, 1998).

A related question when working with young athletes is long term planning. This is a major feature of talent development programs in modern sport. This is especially relevant because some programs have as their objective the identification of youngsters with potential to attain success in sport at national and international levels. It is suggested that a well-organized and intentional program over a long period encourages a more rational use of training methods (Bompa, 1990).

Individual differences in the timing and tempo of the adolescent growth spurt and sexual maturation have a major impact on the body size and performances of boys (Malina *et al.*, 2003). In the context of youth sports, early maturing boys who are taller, heavier, and stronger than their average and later maturing age peers, are often given preference given the associated strength and power advantages. Although such contrasts in size and performance are often transient, they may contribute to the exclusion of potentially talented youngsters largely because they are smaller and are deficient in muscle mass and muscular strength and power (Malina *et al.*, 2003).

It is important to have a grasp of variation in physical and functional characteristics associated with age and maturity status in young athletes. The body size and maturity characteristics of young athletes in a variety of sports have been summarized (Malina, 1998; Malina *et al.*, 2003). Variation in somatotype among youth in many sports has also been summarized (Carter and Heath, 1990). In contrast, variation in functional characteristics, both general and sport specific, of adolescent athletes associated with maturity has received less attention.

The purpose of the present paper is to present the size, physical and functional profile of adolescent football (soccer) players 11-16 years of age. It specifically considers variation by competition age groups, and then examines variation by stage of puberty within these age groups. In addition, a subsample of the players was subsequently examined after an interval of two years, thus providing an opportunity to examine the stabiity of the physical and functional characeristics of the young football players.

2. MATERIAL AND METHODS

2.1. Subjects

The participants were 95 football (soccer) players 10.9 to 16.6 years of age in central Portugal. The players were grouped into two-year age categories which reflect the competitive structure of youth soccer in Portugal: 11-12, "infantiles" (n=29); 13-14, "initiates" (n=37); and 15-16, "juveniles" (n=29). The players were evaluated in the 2000/2001 season. A sample of the players was evaluated again In the 2002/2003 season: 22 of 29 in the 11-12, and 19 of 37 in the 13-14 year age groups.

2.2. Anthropometry

Height, weight, biacromial and bicristal breadths, and the dimensions needed to determine somatotype with the Heath-Carter anthropometric protocol (Carter and Heath, 1990) were taken on each athlete. The androgyny index ([3 X biacromial breadth] - bicristal breadth) was also calculated (Tanner *et al.*, 1951). It provides information about the degree of masculinity in physique.

2.3. Sexual maturity

Stage of sexual maturity was assessed at clinical examination using the criteria for pubic hair described by Tanner (1962). The development of pubic hair (PH) is described in five stages from the prepubertal state (PH 1) to the mature state (PH 5). PH 2 represents the initial appearance of pigmented pubic hair, while PH 3 and PH 4 are intermediate stages (Malina *et al.*, 2003).

2.4. Functional Characteristics

Several dimensions of performance were assessed: (1) cardiovascular endurance - 20-meter shuttle run (PACER: Progressive Aerobic Cardiovascular Endurance Run) and the 12-minute run, (2) running speed - 25 meter dash, (3) agility - 10 × 5 meter shuttle run, (4) explosive power - standing long jump and vertical jump, (5) abdominal muscular strength and endurance - number of sit-ups completed in 60 seconds, (6) static strength - hand grip strength, and (7) lower back/upper thigh flexibility - sit-and-reach.

2.5. Soccer Specific Skills

Two soccer-specific skill tests were administered, passing and dribbling. The tests were adapted from Kirkendall *et al.* (1987).

a) Wall pass

A target area 2.44 m long and 1.22 m high from the floor is drawn on a wall. An area 3.65 m by 4.23 m is marked off on the floor in front of the target area. A restraining line is placed 1.83 m between the baseline and the base of the wall. The ball is set on the restraining line and the subject stands back of the ball ready to kick on the command *go*. The subject continues to kick as many times as possible, with either foot, by immediately kicking the ball or blocking and steadying it, soccer style, before re-kicking. Use of the hands at any time is prohibited, and one point is deducted from the subject's score for each infraction. Three 20-second trials are taken, and the subject's score is the best of the three trial scores. The score is determined by the number of times within 20 seconds that the players successfully propels the ball against the wall. The ball must be directed by the foot, knee or leg. The subject must remain behind the restraining line at all times. If the subject kicks in front of the line, falls forward, or steps over the restraining line during the follow through, the kick does not count.

b) Dribble test

The subject starts to dribble the soccer ball with the feet in and out of markers set at a specific distance from each other. The score is the time elapsed (0.1 second) from the starting signal until the athlete returns to the starting line after dribbling the ball in slalom fashion around the markers. The subjects must complete the test with the ball under control. No practice trials are allowed. Three trials are given. The score of the best trial is retained for analyis.

3. RESULTS

3.1. Comparisons among age-groups

Descriptive statistics for all variables are summarized in Table 1. As expected, size, functional capacities and soccer skills improve with age group with one exception. There is no change in flexibility. In contrast, somatotype does not change significanty with age group. The adolescent soccer players tend to have, on average, a mesomorphic somatotype, with balanced contributions of endomorphy and mesomorphy.

3.2. Maturity-related variation within age groups

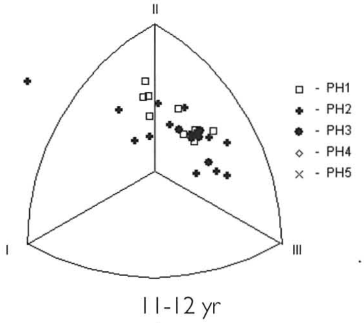
Table 1. Means and standard deviations for size, physique, function and skill of soccer players by age group. Significance of the differences among age groups is also indicated.

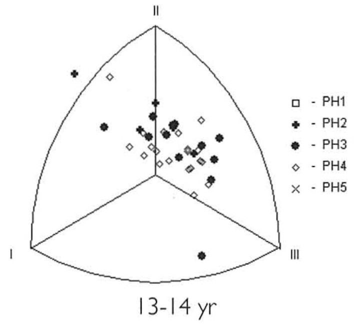
Variable	11-12 yr (n=29)	13-14 yr (n=37)	15-16 yr (n=29)	F (2.94)	p
Age (years)	12.0±0.5	13.9±0.6	16.1±0.5		
Stature (cm)	145.6±5.3	164.0±9.3	172.5±5.1	110.091	**
Body Weight (kg)	37.8±48	52.5±8.3	63.8±5.8	111.405	**
Androgyny index	75.2±3.6	84.1±5.4	92.9±4.6	102.941	**
Endomorphy	3.09±1.31	3.05±0.96	2.73±0.68	1.134	n.s.
Mesomorhy	4.45±0.93	4.30±0.88	4.46±0.86	0.329	n.s.
Ectomorphy	3.27±0.92	3.59±1.03	3.06±0.70	2.856	n.s.
12-minute run (m)	2451±145	2630±258	2760±252	13.502	**
PACER (#)	66±12	86±12	97±10	52.547	**
25-meter dash (sec.)	4.85±0.26	4.48±0.21	3.97±0.19	115.381	**
Agility: 10x5m (sec.)	20.16±1.53	19.13±1.34	18.93±0.91	7.863	**
Vertical jump (cm)	28.0±5.6	33.8±7.6	43.9±6.4	42.539	**
Standing long jump (cm)	162.0±17.7	185.8±24.6	209.9±18.2	54.866	**
Sit-ups (#)	44±9	47±6	56±7	18.042	**
Hand grip strength (kg)	25.1±3.5	34.7±5.4	42.6±7.3	70.629	**
Sit-and-reach (cm)	15.2±4.9	13.7±6.0	15.5±8.2	0.757	n.s.
Soccer wall pass test (#)	14.1±3.0	16.7±3.5	17.1±2.1	9.547	**
Soccer dribble test (sec.)	11.48±0.96	11.06±0.82	10.68±0.86	9.726	**

n.s. (not-significant), * (p<.05), ** (p<.01).

The distribution of stages of pubic hair within single year age groups is summarized in Table 2. The youngest players (11 years) are prepubertal (PH

1) and early pubertal (PH 2). With one exception, all players 12 years and older are pubertal, and one-half of the 16 year old players are classified as mature.





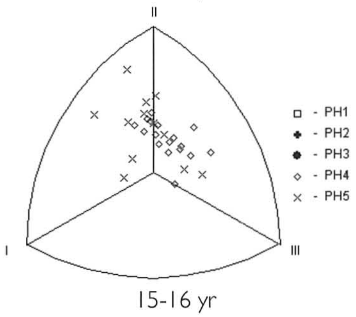


Figure 1. Distributions of somatotypes of soccer players within each age group.

Table 2. Distribution of stages of pubid hair (PH) in soccer players by single year chronological ages (N=95).

Age group	Stages of Pubic Hair					Total
	1	2	3	4	5	
11.0-11.9	8	6	-	-	-	14
12.0-12.9	1	9	5	-	-	15
13.0-13.0	-	5	8	5	-	18
14.0-14.9	-	-	4	15	-	19
15.0-15.9	-	-	-	6	1	7
16.0-16.9	-	-	-	11	11	22
Total	9	20	17	37	12	95

Descriptive statistics for size, physique, functional capacities and soccer skill of soccer players by stage of pubic hair within each age group are summarized in Table 3. Within each age-group players advanced in pubertal status are chronologically older, taller, heavier and more androgynous, although the differences in body weight and the androgyny index are not significant except among 13-14 year old players. In contrasts, somatotypes of players by stage of pubic hair overlap considerably (Figure 1). larger body body size and tend to be more androgynous. Functional capacities and the two soccer skills do not consistently differ among players of contrasting maturity status within each age group, with the exception of cardiovascular endurance (Pacer test), running speed, power (the two jumps) and static strength among 13-14 year old players. Note, however, that sample sizes are rather small, which encourages caution in interpreting the trends.

Table 3a. Means for size, physique, function and skill of soccer players by age group and maturational status (11-12 yr and 13-14 yr).

	11-12 yr (n=29)				13-14 yr (n=37)			
	PH1 n=9	PH2 n=15	PH3 n=5	p	PH2 n=5	PH3 n=12	PH4 n=20	p
Stature (cm)	142.7	145.2	152.0	**	149.5	161.4	169.3	**
Body Weight (kg)	36.6	37.6	40.4	n.s.	43.2	48.7	57.0	**
Androgyny index	74.5	74.9	77.7	n.s.	79.3	82.7	86.1	*
12-minute run (m)	2451	2443	2447	n.s.	2910	2553	2606	*
PACER (#)	61	67	73	n.s.	80	85	88	n.s.
25-meter dash (sec.)	4.89	4.85	4.76	n.s.	4.74	4.55	4.37	**
Agility: 10x5m (sec.)	19.00	17.93	17.55	n.s.	17.31	17.09	17.02	n.s.
Vertical jump (cm)	28.0	28.7	25.8	n.s.	26.8	32.0	36.6	*
Standing long jump (cm)	152.3	166.5	166.0	n.s.	162.8	176.6	192.5	**
Sit-ups (#)	39.9	44.7	48.8	n.s.	44.8	46.1	48.4	n.s.
Hand grip strength (kg)	25.3	24.2	27.4	n.s.	28.1	32.5	37.6	**
Sit-and-reach (cm)	16.8	15.3	12.2	n.s.	13.4	12.8	14.4	n.s.
Soccer wall pass test (#)	14.8	13.9	13.6	n.s.	13.8	18.1	16.6	n.s.
Soccer dribble test (sec.)	11.63	11.41	11.42	n.s.	11.73	11.03	10.91	n.s.

n.s. (not-significant). * (p<.05). ** (p<.01).

Table 3b. Means for size, physique, function and skill of soccer players by age group and maturational status (15-16 yr).

	15-16 yr (n=29)		
	PH4 (n=17)	PH5 (n=12)	p
Stature (cm)	170.8	175.0	*
Body Weight (kg)	60.7	68.2	**
Androgyny index	92.0	94.1	n.s.
12-minute run (m)	2708	2835	n.s.
PACER (#)	94	100	n.s.
25-meter dash (sec.)	4.00	3.93	n.s.
Agility: 10x5m (sec.)	16.90	16.96	n.s.
Vertical jump (cm)	44.9	42.5	n.s.
Standing long jump (cm)	207.8	212.8	n.s.
Sit-ups (#)	56.3	54.7	n.s.
Hand grip strength (kg)	40.9	44.9	n.s.
Sit-and-reach (cm)	15.1	16.1	n.s.
Soccer wall pass test (#)	17.2	17.0	n.s.
Soccer dribble test (sec.)	10.80	10.55	n.s.

n.s. (not-significant). * (p<.05). ** (p<.01).

3.3. Stability over two years

Mean values and interage correlations for the subsamples of athletes observed over a two year interval are summarized in Table 4. Wth the exception of the sum of skinfolds, size, functional and skill variables increased or improved over time. All interage correlations are moderate to moderately high and significant in the younger soccer players, indicating reasonably stability in these characteristics. On the other hand, correlations are lower and not consistently significant in the older players.

Table 4. Means and interage correlations for body size, physique. functional and skill over an interval of two years in soccer players 11-12 and 13-14 years of age at initial observation.

	11-12 to 13-14 years (n=22)				13-14 to 15-16 years (n=19)			
	11-12 yr	13-14 yr	r	p	13-14 yr	15-16 yr	r	p
Age (years)	11.9	13.8			13.9	15.9		
Stature (cm)	144.9	159.3	0.88	**	162.2	170.6	0.80	**
Body Weight (kg)	37.8	49.0	0.74	**	50.8	60.1	0.60	**
Androgyny index	74.8	80.8	0.49	*	84.5	88.4	0.43	*
Sum of skinfolds (mm)	36.9	35.7	0.73	**	37.3	38.3	0.31	n.s.
PACER (#)	66.2	84.3	0.82	**	87.2	95.1	0.66	**
25-meter dash (sec.)	4.88	4.32	0.57	**	4.45	3.91	0.38	n.s.
Standing long jump (cm)	159.0	182.1	0.76	**	182.8	210.8	0.43	*
Sit-ups (#)	43.0	52.0	0.76	**	47.6	54.1	0.66	**
Hand grip strength (kg)	25.2	30.5	0.68	**	34.3	41.3	0.32	n.s.
Sit-and-reach (cm)	15.2	13.0	0.81	**	14.2	17.32	0.57	*
Soccer wall pass test (#)	14.8	20.8	0.50	*	17.0	21.4	0.20	n.s.
Soccer dribble test (sec.)	11.81	10.96	0.70	**	11.13	10.37	0.62	**

n.s. (not-significant). * ($p<.05$). ** ($p<.01$).

4. DISCUSSION

Results of this descriptive analysis of body size and maturity status are consistent with other observations on adolescent soccer players (Malina, 2003). On average, somatotypes are generally mesomorphic with equal development of endomorphy and mesomorphy, which is consistent with other data for adolescent and adult soccer players (Carter and Heath, 1990). Nevertheless, there is considerable variation in the distribution of somatotypes, especially when pubertal status is considered. The role of selection for physique among young soccer players needs further consideration. Individual factors (self) and coach and/or sport related factors are probably involved in this process. This trend is consistent with data presented by Carter and Heath (1990).

It has been suggested that talent in adolescent athletes is largely explained by physical precocity (Helsen *et al.*, 2000). Accordingly, layers born in the latest quarter of the soccer year (October-December) are less likely to be identified as talented. The same has been demonstrated for ice hockey, which has a different calendar year. There is a strong linear relationship between month of birth (January to December) and the proportion of players in the Canadian *National Hockey League* for "Junior A" (Barnsley *et al.*, 1985).

Unfortunately, these analyses do not consider individual differences in the timing and tempo of the adolescent spurt and sexual maturation, and their potential role in the selection process for a specific sport. In the present sample, maturity-associated variation in size, function and skill is greatest among 13-14 year old players (Table 3). This is the age range when most boys progress through these processes and also the age range when there is most variation in performance (Malina *et al.*, 2003). Other data for young soccer players, suggest that early maturing boys (i.e., advanced in biological maturity status) tend to be more often represented among more successful players (Malina, 2003).

Individual differences are also evident in the interage correlations for indicators of size, physique, function and skill (Table 4). This variability in correlations reflects several factors, among others. Two factors of primary importance are individual differences in the timing and tempo of the growth spurt and sexual maturation, and the reduction of maturity-associated variation as the athletes near the cessation of growth and sexual maturity. Measurement variability and perhaps responsiveness of functional tests and skills to training and practice are additional factors.

Research is missing to analyse the expectations of coahes towards youth athletes contrasting in physical status, body size and strength. It also would be of interest to assess satisfaction for participating in sports of late and advanced mature athletes. A draft was done by Coelho e Slilva *et al.* (2003) who studied the correlates of playing time in young soccer players.

5. IMPLICATIONS AND RECOMMENDATIONS

The data for adolescent soccer players provide a general profile of their growth, maturity, functional and skill characteristics. Coaches need to be aware of such data, especially inter-individual variation. There is a need for study of coaches of youth soccer players, especially from the perspective of their perceptions and expectations of athletes who differ in size, maturity status and skill. Preliminary data suggest considerable variation in playing time associated with functional capacity and skill. For example, coaches tend to promote players (more playing time) on the basis of motor fitness and soccer specific skills, whereas somatotype and body size do not seem to be relevant predictors for playing time in this age group of 15-16 year old players (Coelho e Silva *et al.*, 2003). Corresponding data are needed for younger age groups when variation in size and maturity is much more apparent.

Taking into account the information provided by the present study, the following suggestions should be of interest to coaches and sport authorities:

- *It might be more practical to group athletes into more homogenous age-groups, especially during early phases of sport participation*

  During the transition into puberty and during puberty, age groups of one year (12 months) may provide better opportunities for all players and give coaches a better view of ability and potential. With two year age groups, athletes who are successful at one level, e.g., 11-12 years, may not attain as much success when they move into the next age category, i.e., 13-14 years, when they will likely be smaller and less fit (strength, speed, power, etc.) than the older and more mature players in the age group.

- *The potential value of matching yound soccer players by maturity status should be systematicall evaluated.*

  Sport authorities already permit the moving up of younger, advanced players into older age-groups. Hence, it may be worthwhile to try matching players by maturity status in younger age groups, especially 11-12 and 13-14 years. This may necessitate less mature older players compete against younger athletes of similar maturity status. Though interesting, it is important to examine the implication of such matching for behavior and peer relations. Asking a 14 year old, slow maturing player to compete with 11-12 year olds may have negative behavioral implications. Similarly, asking a more mature 12 year old to compete with 14 year olds may also have negative behavioral implications (see Malina, 2000).

- *The identification of potentially talented individuals should not place too much reliance of size, strength and power advantages associated with early biological maturation in early and mid-adolescent players to the neglect of skill mastery and game sense.*

  Talent identification is a complicated process (see Malina, 1997). Many factors are involved. Selection is the first phase, and all too often initial selections are based on limited data. Coaches need to be aware of changes in size, function and skill associated with adolescence, and their behavioral implications. After all, adolescent athletes are first adolescents and then athletes.

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MATURATION AND STRENGTH OF ADOLESCENT SOCCER PLAYERS

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1. INTRODUCTION

Sport training during growth depends on the morphological characteristics and stage of maturation. In boys the association between biological maturation and various anthropometric characteristics is most striking up to about 16 years of age. Motor skill and physical fitness tend to be optimized during adolescence, especially strength and power, which depend in part on fat-free mass (FFM). The onset and termination of adolescence, however, vary considerably among boys, and this may confound the relationship between maturity status and motor performance.

Biologically more mature boys often achieve better performance results and are commonly included among young athletes in baseball, football, soccer, swimming, tennis, and ice hockey (Beunen *et al.*, 1997). However, performance differences among boys of contrasting maturity status within specific age groups are somewhat reduced. This may be related to three factors: the nature of the biological maturation variables and errors of assessment; the specificity of tests used to evaluate motor performance, which may be related to sport modality and may be influenced by training and learning; and the use of mean comparisons which limits appreciation of variability among individuals.

This study evaluates different methods of maturity assessment in young soccer players in an attempt to identify the best combination of indicators that can differentiate among individuals of contrasting maturity status during adolescence. It also considers the association between morphological and maturational characteristics, and muscular strength to estimate variation associated with maturity status.

2. METHODS

The sample included 71 boys, 13 to 16 years of age, who attended one of Portuguese top soccer clubs located in the Lisbon metropolitan area. Time spent in sport-specific training was, on average, 8 hours/week, which is less than one-half of the amount of time spent on training in elite sport schools in other countries, about 18-30h/week plus a specific number of days at sport camps (Malina *et al.*, 1997).

Anthropometric dimensions were obtained following the protocol in Fragoso and Vieira (2000). The dimensions included measures of overall body size (weight and height, the body mass index [BMI] was calculated), segment lengths (sitting height, arm length, leg length), skeletal breadths (biacromial, biiliocristal, biepicondylar humerus and femur, stylion ulna), skinfolds (biceps, triceps, subscapular, iliac crest, abdominal, thoracic, axillary, thigh, medial calf), and girths (relaxed and tensed [flexed] arm, forearm, thigh, calf). Strength was measured with three tests, the contra movement jump, maximal leg strength and handgrip strength. Handgrip strength was used as the primary strength variable for detailed analysis.

Measures of maturity status included skeletal age and stages of sexual development. Skeletal age of left hand and wrist was assessed by an experienced rater blinded to the chronological age (CA) of the subjects. Thirteen bones were rated with the Tanner-Whitehouse III Method (TW3). The TW is the method of choice in most growth studies (Gilli, 1996). Sexual maturity status was self-evaluated on the basis of five stages of pubic hair [P1-P5] and genital [G1-G5] development) using the criteria of Tanner (1962). Age of voice was obtained prospectively according to the proposed criteria of Cameron (personal communication). Permission from parents and from the boys (self assent) were obtained before data collection.

Descriptive statistics were calculated for the total sample and single year age groups. The data was examined for collinearity and nonparametric correlations between indicators of maturity were done. Principal component analysis of the three indicators of sexual maturity was used to derive a maturation index based on the factor score. The subjects were then divided into three sexual maturity categories (SMC): initial stages (IS), median stages (MS), and last stages (LS) of sexual maturation. IS and LS had factor scores that were, respectively, less or more than 0.5 standard deviations from the mean.

A multiple nonparametric comparison test (Kruskal-Wallis) involving rank orders and an ANOVA and SCHEFFE techniques were used to test differences in handgrip strength among the three maturity groups. A linear model was developed for handgrip strength and maturity category to examine the influence of morphological and maturity variables on strength. The probabilities of F for entrance and removal of the variables were of 0.05 and 0.10 for all variables. The analyses were carried out with SPSS 11.5 software for Windows.

3. RESULTS

Table 1. Means and standard deviations handgrip strength, chronological age and skeletal age.

	Mean	SD	Max	Min
Handgrip (kg)	43.3	10.5	66.0	24.0
Bone age (yrs)	14.9	1.80	16.5	10.0
Chronological age (yrs)	14.7	1.10	16.9	13.1
Bone age-Chronological age (years)	0.12	1.28	2.87	-3.40

Descriptive statistics for handgrip strength, chronological age (CA) and skeletal age (SA) are summarized in Table 1. Corresponding statistics for CA, SA, strength and anthropometric variables are summarized by single year age categories from 13 to 16 in Table 2. Most of the subjects studied presented a slightly advanced biological age (SA) compared to CA.

The variables presented in Table 2 were used in the regression and were selected after the intercorrelations and dimensionality of anthropometric, SA and sexual maturity were analysed. Mean SA is very similar to CA in 13 and 14 year old boys, and then is in advance of CA among 15 year old boys until 15 years. Among 16 year old boys, SA and CA are about equal as boys approached skeletal maturity or were already skeletally mature. As expected, height increases between age groups from 13 to 15 years, and then is about identical in 15 and 16 year old boys. Upper leg length and stylion-ulnar, biepicondylar femur and maleolar breadths do not differ significantly between 13 and 16 years. The same is true for the thigh, calf and axillary skinfold thicknesses. In general, trunk breadths, especially biacromial breadth, and arm and thigh girth increase with age.

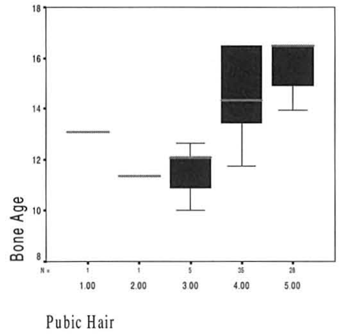
Table 3 summarizes the distribution of stages of sexual maturity in the total sample of boys. There is variation among maturity indicators, but the majority of boys are in stages comprised between 3 and 5. Box plots (Figure 1) show the relationship between bone age and the three indicators of sexual maturity. Almost the entire sample has subjects within level four and five for pubic hair, in level three for voice stage, which means that these subjects have voice alterations for less than two years, and is between level three and four of genital development. At level three of voice and genital stage bone age vary between 10 to 16 years although quite symmetrically on both directions of the mean when speaking about voice stage. The variability of bone age considering the different stages of development of pubic hair is smaller than the one observed for the previous described sexual characteristics.

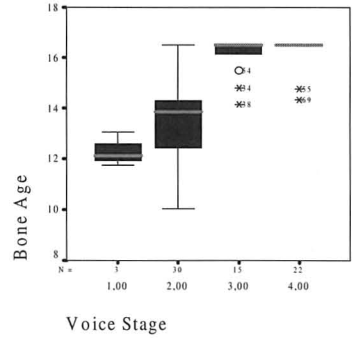
Table 2. Means and standard deviations of all variables by single year age groups.

	Mean	SD	Mean	SD	Mean	SD	Mean	SD
N	27		17		13		14	
Chronological Age	13.6	0.2	14.6	0.2	15.5	0.3	16.5	0.3
Bone Age (years)	13.4	1.5	14.9	1.5	16.2	0.7	16.5	0.0
BA-CA	- 0.23	1.54	0.34	1.47	0.74	0.89	0.01	0.29
Stature (cm)	162.2	8.5	168.6	10.7	175.2	6.1	174.7	5.4
Weight (kg)	53.4	9.7	59.1	10.7	67.3	4.7	72.1	6.0
Sitting height (cm)	84.2	4.7	88.0	6.0	91.3	2.8	92.2	3.1
Body Mass Index (kg/m^2)	20.1	1.9	20.6	1.6	21.9	1.0	23.6	1.7
Upper Arm Length (cm)	33.5	1.9	34.0	2.6	35.7	2.0	39.1	11.4
Upper Leg Length (cm)	41.6	2.3	45.2	12.8	44.3	2.8	44.3	2.6
Thoracic Length (cm)	17.1	1.6	19.2	1.8	20.4	1.6	19.1	1.9
Biepic. Humer. Breadth (cm)	6.4	0.5	6.5	0.5	6.9	0.4	6.9	0.5
Stylion-ulnar Breadth (cm)	5.3	0.6	5.4	0.6	5.5	0.4	5.6	0.2
Biepic. Femur Breadth (cm)	9.3	0.9	9.0	0.5	9.6	0.6	9.3	0.4
Malleolar Breadth (cm)	10.0	14.4	7.4	0.4	8.3	2.7	7.7	0.4
Biacromial Breadth (cm)	34.9	2.5	36.0	2.6	37.8	1.6	39.0	1.6
Torax Transv. Breadth (cm)	24.8	1.9	25.3	1.8	26.1	1.3	28.5	2.2
Torax Sagital Breadth (cm)	16.6	1.7	15.7	2.0	16.7	1.0	19.2	1.6
Biiliocristal Breadth(cm)	23.8	1.8	24.7	2.4	25.4	2.3	26.9	1.6
Tensed Arm Girth (cm)	25.4	2.4	27.2	2.3	29.7	1.7	31.1	1.6
Thigh Girth (cm)	46.5	3.5	47.4	4.0	50.8	2.4	54.4	2.1
Calf Girth (cm)	33.7	3.0	35.8	2.4	37.1	1.3	37.9	1.1
Thoracic Girth (cm)	74.3	5.7	78.3	5.2	82.3	1.4	86.3	3.9
Abdominal Girth (cm)	70.7	4.8	74.5	5.4	78.5	3.0	79.7	5.0
Biceps Skinfold (mm)	4.1	0.9	4.4	1.3	4.5	1.5	5.3	1.2
Triceps Skinfold (mm)	8.1	2.4	8.9	3.3	8.7	2.0	11.0	3.7
Thigh Skinfold (mm)	11.5	3.3	11.8	4.0	10.8	3.0	12.4	2.3
Calf Skinfold (mm)	8.0	2.3	8.8	3.1	7.7	2.5	9.1	3.5
Subscapular Skinfold (mm)	6.5	1.3	7.3	2.0	8.0	1.1	9.6	2.4
Axilar Skinfold (mm)	5.4	1.2	5.3	1.1	5.5	1.0	6.3	2.5
Abdominal Skinfold (mm)	8.4	2.6	9.0	4.1	10.5	3.2	13.0	5.4
Handgrip (kg)	33.9	6.4	45.3	9.1	50.5	5.0	52.6	7.3

Table 3. Total number of boys in each level of genitalia, pubic hair and voice development.

	Stage				
Indicator	1	2	3	4	5
Pubic hair	1	1	5	36	28
Genital	0	20	33	13	5
Voice	0	3	30	16	22





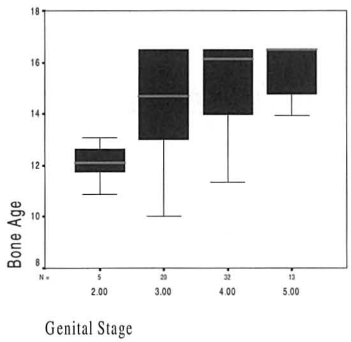


Figure 1. Box-Plots for bone age by stage of by sexual maturity

Stages of sexual maturity are associated with considerable variation in skeletal maturity. This suggests that skeletal and sexual maturation are not necessarily synchronous, although SA and stage of sexual maturity are scored on mathematically different scales and the number of pre- and early-pubertal boys in the sample is quite small. Nonparametric correlations between SA and stage of sexual maturity are significant: voice, r=0.82; pubic hair, r=0.50; and genitalia, r=0.31.

The principal components analysis of the three indicators of sexual maturity yielded one component with an eigen value >1.0. It accounted for 67% of the variance (Table 4). Although results were very similar for the three indicators, pubic hair was most highly related with the first principal component (Table 5). The unstandardized 'sexual maturity index' (SMI) for this sample of 13-16 year old boys was: SMI = 0.405 x VS + 0.561 x PH + 0.480 x GSA.

Table 4. Initial eigenvalues and total variance explained by sexual maturational variables (pubic hair, genitalia development and voice alteration).

Component	Eigen Value	% of Variance	Cumulative %
1	2.00	66.9	66.9
2	0.59	19.6	86.5
3	0.40	13.5	100

Table 5. Correlations with the first component.

	Component 1
Voice Stage (VS)	0.785
Pubic Hair (PH)	0.863
Genital Stage (GS)	0.803

Table 6 shows the correlations between handgrip strength, bone age, each indicator of sexual maturity and the sexual maturity index (SMI). Handgrip strength is related with bone age, voice stage and SMI. As expected, the three indicators of sexual maturity and the SMI are highly intercorrelated

Table 6. Matrix of correlations of different sexual maturation variables.

	HG	BA	VS	PH	GS	SMI
Handgrip	-	0.75	0.73	0.38	0.24	0.53
Bone Age		-	0.83	0.50	0.31	0.66
Voice Stage			-	0.46	0.35	0.73
Pubic Hair				-	0.55	0.84
Genital Stage					-	0.79
SMI						-

All coefficients are significant, $p \leq 0.05$.

To study the association of handgrip and maturity, the sample was divided into three maturity categories as described in the methods (Table 7). More mature subjects are significantly stronger than less mature boys between 13-16 years. Post hoc multiple comparisons indicate that there are significant differences between the IS and LS, and between IS and MS, but no difference between MS and LS (Table 8).

To further evaluate the association of handgrip strength and maturity, several highly correlated variables were considered in an attempt to reduce the dimensionality. The correlation matrix and the corresponding proximity tree showed that bone age in boys is strongly correlated with limb girths. Linear dimensions also had high intercorrelations, so one or two variables were chosen as representative. According to the correlation matrix and dendrogram, almost all girth variables were not included in the statistical treatment. The stepwise method was used to adjust the linear regression model for handgrip strength. The variables chosen for each maturity group were obtained assuming that all the covariates could enter in the full model.

Table 7. Kruskal Wallis test for differences in handgrip strength among sexual maturity groups

HG	Stage	N	Mean Rank
	Initial	15	14.3 kg
	Median	29	38.0 kg
	Last	27	45.9 kg
HG	Chi-Square	Df	p value
	23,087	2	0.000

Table 8. Multiple comparison of handgrip strength among the three sexual maturity groups (nonparametric tests).

Group		Mean Difference	Standard Error	Significance
Initial	Last	-31.57 kg*	5.51	.00
	Median	-23.73 kg*	5.44	.00
Last	Median	7.83 kg	4.57	.24

* p< 0.05 level.

Table 9. Four adjusted linear regression models for "handgrip strength" for the all sample and for each maturational group level.

	Total Sample	IS	MS	LS
Boys	Coef.	Coef.	Coef.	Coef.
(Constant)	-67.159	-27.040	-50.722	-27.358
Bone Age	2.064			
Chronological Age	4.025		6.370	4.355
Upper Leg Length		-1.405		
Biacromial Breadth		1.042		
Stylion-ulnar Breadth	3.765			
Malleolar Breadth		11.382		1.306
R Square	0.66	0.85	0.44	0.57
Adjusted R Square	0.64	0.81	0.41	0. 53
Standard error	6.31	2.18	8.42	5.01

Results of the regressions are summarized in Table 9. Bone age appears in the regression only for the total sample. This suggests a role fo variation in biological maturity in handgrip strength across the age range 13-16 years. Within the specific maturity categories, CA appears a predictor in the MS and LS groups, but not in the IS. This may reflect the limited age range of the sample of boys in the early stage of sexual maturation. It is of interest that skeletal dimensions appear among the significant predictors of strength in the least mature group (IS). Finally the robustness of arm bones also influences the handgrip result.

4. DISCUSSION

This group of soccer players at 13 years is composed of boys who are only slightly later maturing; their bone ages are slightly lesser than their chronological ages (-0.23). The 15 year old players, on the other hand, are significantly advanced in skeletal maturity; bone age is advanced over CA by along one year (Table 2). These trends suggest that late maturing boys may give-up soccer or may be systematically removed from training programs. On the other hand, the sport of soccer may systematically select for boys advanced in maturity as adolescence progresses. The small difference between 15 and 16 year old boys probably reflects reduced variation as the end of adolescence is approaching.

Biological maturity can be assessed in several ways, and the two more commonly used methods are based on secondary sex characteristics and skeletal age. This study attempted to combine these methods with moderate success. The majority of this sample of soccer players were in stages four and five for pubic hair, which is consistent with observations that boys practicing sport enter each stage of genital and pubic hair development earlier than non-athletes (Malina *et al.*, 1997).

Indicators of sexual maturity vary somewhat with overall bone age variability, so that skeletal and sexual maturation do not necessarily proceed synchronously. The nonparametric correlations between stage of each indicator of sexual secondary and bone age were 0.83, 0.50 and 0.31, respectively, for stage of voice, pubic hair and genitalia. The variable results may reflect error associated self-evaluation and bone age assessment, and also the different scales used for sexual maturity (5 stages) and bone age (continuous). There is also the possibility of population variation in indicators of biological maturation (Kemper *et al.*, 1997).

Adolescents are commonly categorizes as prepubescent, pubescent and post-pubescent, or dichotomized as advanced and delayed. The observed variance in this study between individuals in different maturity categories was considerable which suggests that one single system of maturity assessment may not be sufficient for a complete description of growth and performance among adolescents. However, studies incorporating indicators of skeletal, sexual and somatic maturity suggest a general maturation factors affecting that the timing of growth and maturation during adolescence (Bielicki *et al.*, 1984; Malina, 1989; Malina and Bouchard, 1991). Hence, it may be possible to use a single maturity indicator and the sexual maturity index (SMI) developed in the present study may be appropriate.

To evaluate maturity-associated variation in handgrip strength, the sample was divided into three contrasting maturity categories as described in the methodology. Boys advanced in maturity (LS, MS) were stronger than those who were in the early stages of maturation (IS).

The association between morphology, maturation and performance has been considered in many contexts. In general, there is a correspondence between sport and/or level of sport participation and morphologic features such as stature, arm span, the height of the center of gravity, linearity, muscle-skeletal robustness, and body composition (Carter, 1988; Malina and Bouchard, 1991; Vieira *et al.*, 2002). The present study showed that bone age is an important variable for handgrip strength in the total sample of soccer players. This is consistent with the generalization that boys advanced in physical growth, particularly in stature, also have a greater LBM, muscle mass and heart volume, and as a result tend to perform significantly better (Baxter-Jones, 1995; Malina and Bouchard, 1991).

Bone age and chronological age were major predictors of handgrip strength in the total sample (Table 9). This may suggest that in similar circumstances of biologic age, chronological age becomes an important factor in variability. This in turn may reflect the advanced experience and longer training history of the older soccer players compared to the younger players. The robustness of wrist bones also appeared as a predictor of handgrip strength in this sample of boys.

Within the three maturity categories, bone age did not appear as a predictor of strength; rather, in the MS and LS categories, chronological age was the major predictor. In contrast, in IS, skeletal breadths were the major predictors of handgrip strength. Once again, the role of chronological age may be reflected in experience and longer training history.

5. CONCLUSIONS

- High commonality of indicators of sexual maturity suggests that it may be desirable to work with only one indicator. A weighted vector like SMI based on voice, pubic hair and genital development is a potential method including all three criteria.
- Bone age is an most important explanatory variable of handgrip strength.
- The use of a regression model to predict handgrip strength may be especially useful during the initial stages of pubertal maturation.

- It is important that the findings of the present study be replicated in other and larger samples of soccer players and participants in other sports.

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YOUTH SOCCER: A BIOCULTURAL PERSPECTIVE

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1. QUESTIONS TO CONSIDER?

- What are the growth and maturity characteristics of young soccer players?
- How does growth and maturation impact upon the socialization process in youth soccer?
- Does maturity status act as an exclusionary factor in elitist youth soccer programs?
- How does maturity status influence the nature and quality of young soccer players' interactions with adults?

> "It's a game of athleticism, a game of power and competition and strength. Anybody who thinks football is just a game of deftness of touch without those other things wouldn't win".
>
> Sir Bobby Robson, professional soccer manager.

If one is to understand participation behavior and performance in youth soccer, it is important to recognize the contribution and interaction of various biological, psychological and cultural factors. Sport may be a social phenomenon, but the biological organism performs within a particular cultural context (Malina, 2002). Researchers studying the socialization process in youth soccer would do well to adopt a biocultural perspective. To date, however, few psychologists or sociologists have examined the contribution of biological or maturational factors upon the socialization process in youth sport (Weiss and Glenn, 1992). With this in mind, the purpose of this chapter is to review the extant literature and discuss theoretical and research issues as they relate to the biological maturity status of young soccer players and how it may impact upon the socialization process in the sport.

2. THE MEDIATED EFFECTS MODEL OF PSYCHOLOGICAL AND BEHAVIORAL ADAPTATION TO PUBERTY

The mediated effects model of adaptation to puberty assumes that the psychological and behavioral effects of puberty are mediated by the individual's "...ideation about his or her biological changes and the subjective meaning or affective significance attributed to them" (Peterson and Taylor, 1980, p. 137). In short, the effects of pubertal changes are mediated by intervening variables or moderated by exogenous or contextual factors. Young athletes' subjective evaluations of their maturational development may be partially derived from cues in their immediate social environments (e.g., parents, peers, coaches, administrators). Research examining the psychological and behavioral consequences of early and late maturation has shown that the peer and parental environments are especially instrumental in determining adolescent satisfaction with bodily changes change (Blyth *et al.*, 1985; Faust, 1983; Peterson and Taylor, 1980).

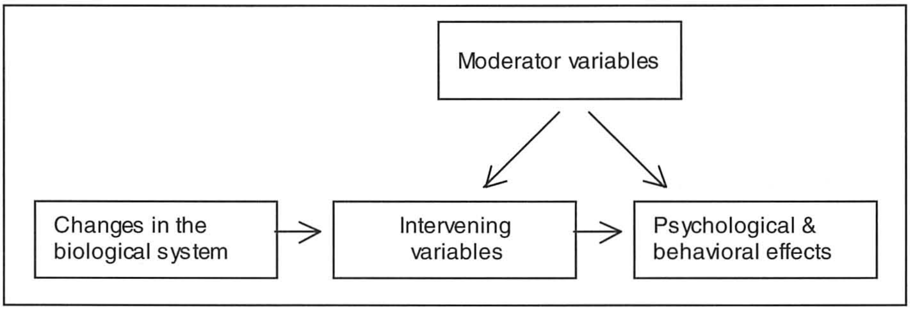

Figure 1. Mediated Effects Model of Psychological and Behavioral Adaptation to Puberty (Adapted from Peterson and Taylor, 1980)

Maturity associated changes in height, weight, body composition, and physical aptitude may have significant social stimulus value for male and female athletes. The evaluations, reactions, and impressions conveyed by parents, peers, coaches, and/or administrators may directly or indirectly communicate positive or negative information regarding physical appearance, competence or autonomy. Adults rate early maturing males as having superior physiques and physical abilities (Jones and Bayley, 1950). This tendency is most evident beyond the age of 14 years. Little information is available on how adults rate the physical characteristics or aptitude of early and late maturing females. Research does, however, suggest that the family environment is influential in helping females adjust psychologically and behaviorally to the physical changes associated with maturation (Brooks-Gunn and Ruble, 1983). Similarly, the reactions of significant others, i.e., peers, educators, family, and so on, are instrumental in determining the perception of adolescent females own physical attractiveness (Schonfeld, 1964).

3. GROWTH AND MATURITY CHARACTERISTICS OF YOUNG SOCCER PLAYERS

The size, physique, and functional characteristics of young athletes typically reflect the demands of specific sports. To this end, soccer is a sport that requires a high degree of both skill and athleticism. The height, mass and biological maturity status of male youth soccer players has been documented in a number of European, Latin American and North American countries (Malina, in press). The average heights and weights of samples of male youth soccer players, most of which could be classified as elite, fluctuate about the reference medians for the general population from childhood through mid-adolescence. In later adolescence, however, average heights of male soccer players typically fall at or below the reference medians, while mean weights continue to fall above the reference medians. The greater weight-for-height of soccer players most likely reflects an increase in the proportion of fat-free mass (i.e., muscle mass) and a dominantly mesomorphic physique (Malina, in press; Carter and Heath, 1990).

Male youth soccer players are, on average, typically advanced in biological maturity status, particularly after the age of 13 years (Malina *et al.*, 2000; Malina, in press). This is not surprising; advanced maturity in males is associated, on average, with larger stature, body mass and fat-free mass, and greater physical competence as reflected in standardize performance tasks of speed, strength, power, and so on. Italian youth soccer players, when compared with control samples, were more advanced in biological maturity status (skeletal and genital), particularly after 12-13 years of age (Mazanti *et al.*, 1989). Mexican (Peña-Reyes *et al.,* 1994) and Portuguese (Malina *et al.*, 2000) male soccer players were advanced in skeletal maturity after 13-14 years of age. The advanced maturity status of young soccer players was especially apparent during mid-adolescence (13-15 years), which is the interval of the adolescent growth spurt in the majority of boys. In later adolescence, there is catch-up of later maturing boys so that maturity-associated variation in size and performance is reduced.

Despite the growing popularity of women's soccer, little information exists on the growth and maturation of female youth soccer players. The few studies that have been conducted with female soccer players indicate that from late childhood to early adulthood the heights of female soccer players are, on average, marginally above the median reference values for their age

(Cumming, 2002; Siegel, 1995). Across all ages, the female soccer players also tend to have longer legs than the general population (Siegel, 1995). The weights of female soccer players typically fall at or above median reference values, except in later adolescence and early adulthood when the weight of the players is consistently above the reference median (Cumming 2002; Siegel, 1996). In late childhood and early adolescence the weight-for-height of female soccer players, as expressed by the body mass index (BMI, kg/m^2), varies above and below the median reference values for the general population. Between the period of late adolescence and early adulthood, however, the BMI of female soccer players is typically above reference medians (Cumming, 2002; Siegel, 1996), indicating as in male soccer players proportionally more weight-for-height. The somatotypes of female soccer players are reasonably well-balanced in late childhood and adolescence between. In early adulthood, however, players tend to be, on average, mesomorphic endomorphs (Siegel *et al.*, 1996).

Although data are limited, female soccer players, like female athletes in many team sports, tend to approximate the average, i.e., are "on time," in biological maturity status (Malina, 1983, 2002; Malina *et al.,* in press). The data for female players are based on the age at menarche, which is a late event in the adolescent sequence of pubertal events. Menarche occurs, on average, about one year after peak height velocity (Malina *et al.*, in press). As noted earlier and in contrast to female soccer players, male soccer players tend to be advanced in biological maturity (skeletal age and sexual maturation).

4. THE IMPACT OF BIOLOGICAL MATURITY STATUS UPON THE SOCIALIZATION PROCESS IN YOUTH SOCCER

The physical and functional characteristics associated with maturity status may have significant social stimulus for coaches, administrators, and/or parents. Early maturing males and average-to-late maturing females have, on average, physiques and functional characteristics that are more suitable for success in soccer. Soccer is a sport that requires aerobic and muscular endurance, speed, power and agility, and characteristics associated with late maturation in boys and early maturation in girls are associated, on average, with poorer levels of physical performance in these functional requirements of soccer. This does not mean that all late maturing boys and early maturing girls are excluded from the sport because of their maturity status. Rather, they are simply less likely to be represented in the sport at more successful or elite levels during adolescence. Indeed, the challenge for adults who train and develop youth soccer players is to provide opportunities for the skilled late maturing boy and skilled early maturing girl to experience success in the sport so that their motivation will be maintained and they will persist in the sport.

Players who are more successful or who have greater physical potential for success in a sport, specifically soccer, may receive greater encouragement from adults to play, more positive feedback, and more opportunities to further develop their skills (i.e., access to better coaches, invitations to play for elite level programs or attend elite player development camps). Indeed, perceptions of positive coaching behavior were positively correlated with soccer self-esteem in a sample of Norwegian male youth soccer players (Ommundsen and Vaglum, 1991a).

Greater physical potential for success in soccer, however, does not always result in more favorable reactions from adults. High expectations for success may lead adults to exert a greater degree of pressure or control over youth who are physically more gifted for playing soccer. Male soccer players who were older and more advanced in maturity status were more likely to perceive their coaches as controlling as opposed to being supportive of autonomy. In contrast to the observations for males, estimated maturity status of female soccer players was unrelated to perceptions of autonomy support from coaches or parents (Cumming, 2002). Previous sport-based research has also shown that coach-created situations perceived by athletes as controlling (i.e., being told what to do and how to do it) undermine the intrinsic motivation, creativity, and self-expression of athletes (Vallerand, 2001).

Biological maturity may also act as an exclusionary factor in youth soccer, particularly males. Elite youth soccer programs may systematically exclude male players on the basis of maturity status (Malina, 2002). A study of males playing for several elite male youth soccer teams in Portugal indicated an equal proportion of early and late maturing players prior to 13 years of age (Malina *et al.*, 2000). The proportion of early maturing males, however, increased significantly in the older adolescent age groups (i.e., 13-16 years). Similarly, in a study comparing the estimated maturity status of male youth soccer players competing in travel and recreational soccer programs in Mid-Michigan (U.S.), males playing travel soccer were more advanced in maturity status (Cumming, 2002).

Corresponding data for females are very limited, and comparisons of elite and non-elite female soccer players are lacking. Some data limited to estimated maturity status based on predicted adult height suggest no differences in the maturity status of females in recreational and more competitive travel programs (Cumming, 2002). More research is warranted to ascertain the potential exclusionary impact of variation in biological maturity status in female youth soccer programs. Although maturity status may not act as an exclusionary factor in more elite level programs for females, it may act to exclude females from general participation in soccer which may have implications for patterns of habitual physical activity.

Maturity-associated variation in size, muscularity and physical competence is most evident between the ages of 11 and 13 years in females and 13 and 15 years in males. However, such variation begins to manifest itself in the years immediately preceding, the initiation of the transition into adolescence for most girls and boys, about 9-10 and 11-12 years, respectively (Malina *et al.*, in press). Issues related to the potential impact of maturity status per se and associated changes in size, body composition and performance upon motivated behavior and treatment of talented young athletes need more systematic attention in the sport psychology research community.

The chronological age of a child and the range of the age group for competition may accentuate the impact of variation in biological maturity status on the processes of inclusion and exclusion in soccer and other sports. This is related to when a youngster is born within the selection or competitive year. At present in soccer, January 1 marks the beginning of the selection or competitive year (it is August 1 for Little League Baseball). Male youth soccer players who are born in early in the selection year are thus the oldest children in an age group and are more likely to be identified as talented, to be exposed to higher levels of coaching, and to be represented more often at the professional and national levels. Players who are born in the later quarter of the selection year tend to drop out of soccer, either voluntarily or perhaps systematically, around the age of 12 years (Helsen *et al.*, 1998). This phenomenon is referred to as the 'season-of-birth bias' (Simmons and Paull, 2001). It has been observed in elite youth and professional adult soccer players in the Netherlands, England, Belgium, Sweden, Germany, Brazil, Japan, and Australia (Brewer *et al.*, 1995; Helsen *et al.*, 1998; Musch and Hay, 1999; Simmons and Paull, 2001). The season-of-birth bias also shifts with start date of the competitive year. In England, the selection year starts in September. The majority (58.7–71.8 %) of players selected for the English Football Associations centers of excellence were born between September and December (Brewer *et al.*, 1995). In Sweden, where the selection year starts in January, the majority of male soccer players (62.2–62.7%) were born between January and April. In a sport such as soccer, where greater physical size and functional capacity are generally desirable, players born early in the competitive year have a distinct advantage.

The manner in which players are grouped may also accentuate the impact of age and biological maturity status upon the processes of inclusion and exclusion. The majority of youth soccer programs in the United States group competitors by chronological age, typically using two-year age brackets (e.g., 11-12 [11.0-12.9] years, or 13-14 [13.0-14.9] years). In addition to a relatively broad range of variation in chronological age within the age group, players vary considerably in biological maturity status. Indeed, an 11 year old boy who is late in maturity and a 12 year old boy who is advanced in maturity may vary by as much as 4 or 5 years in biological age (Malina *et al.*, in press). Many soccer programs in Europe, particularly those in communities where there are a limited number of children, group players relative to an upper age limit (e.g., under 16 years, under 17 years). This allows for more players within a broader age range. However, the broader the age range, the greater the potential impact of chronological age per se (which often translates into experience in the sport) and biological maturity status on the processes of inclusion and exclusion in the sport.

Players who are younger and/or later in biological maturation may struggle to compete against youth who are older and/or more advanced in maturity. These players may become discouraged and drop out of the sport, or they may be systematically excluded by the sport. Note, however, that in later adolescence (17-18 years of age), the differences in size and performance among boys of contrasting maturity status are reduced considerably. Indeed, it is often the later maturing boy who attains a greater height in young adulthood (Malina *et al.*, in press). A question of interest is the following: Are talented later maturing boys excluded from the sport due in part to the size, strength and power disadvantage associated with their maturity status early in adolescence, and in part to the preferences of coaches for larger, more powerful boys who tend to be advanced in biological maturity? A related question that needs attention is the following: How can the sport retain or protect skilled smaller, later maturing boys as they progress through adolescence?

Corresponding questions regarding the socialization and/or selection of girls for soccer have not yet surfaced. Nevertheless, the potential impact of issues raised in the context of boys' programs needs consideration in programs for girls.

The physical characteristics of young soccer players may also influence the amount of playing time and coach attention. Later maturing males and earlier maturing females may spend a significant amount of time on the bench (i.e., not playing), particularly if the coach places a high priority on winning and/or the league/program has no policies regarding equal playing time. Youth who are not selected to play for more elite soccer programs, or do not receive equal playing time, may begin to doubt their competence as soccer players and as a result may believe that they do not the competence to be successful in soccer. Low perceptions of competence, in turn, can have profound psychological and behavioral ramifications during adolescence. Youth who doubt their ability to perform or learn in an achievement arena typically report reduced enjoyment and greater anxiety, and are more likely to drop out of that activity (Weiss and Chaumeton, 1992). Among Norwegian male soccer players 12 to 16 years of age, low perceptions of soccer competence and peer popularity negatively influence persistence in the sport. The relationship was mediated in part by changes in the enjoyment of soccer. Perceptions of competence were most predictive of enjoyment and continued participation among males 14 to 16 years of age (Ommundsen and Vaglum, 1991b).

The implications of the growth and maturity characteristics of young soccer players extend beyond the processes of inclusion and exclusion. It has been alleged that youth soccer coaches affiliated with professional soccer clubs have recruited physicians to help accelerate the growth and maturity of talented yet physically smaller players. Burns (1996), for example, reported that Diego Maradona, the former captain of the Argentinean national soccer team, had undergone treatment to accelerate his growth and maturity while playing for Cebollitas, a youth team affiliated with Argentinos Juniors. It is unclear, however, what exactly the treatment involved. In an interview with Burns (1996), Francisco Cornejo, the head trainer at Cebollitas discussed how Maradona was given a series of vitamins and injections:

> *"Diego was so small when I took him on that he didn't seem to be strong enough. I wanted Paladino (the physician) to round him off, get him fatter and bigger. So I asked the doctor to give him vitamins and other things to help him develop. Cacho (Palidino) I said to him, you fix him. This boy is going to grow up to be a star" (Burns, 1996, p. 19-20).*

On meeting Maradona, Paladino believed that "the boy looked thin – not necessarily underdeveloped for his age, but lacking sufficient weight to be a successful sportsman" (Burns, 1996, p. 20). Paladino later declared the treatment a success stating that "When I finished with him (Maradona) he was like a racing colt" (Burns, 1996, p.20).

Chemical substances such as synthetic growth hormone and anabolic steroids have been allegedly used to improve the physical status of young athletes. This approach, however, compromises the physical and psychological health of the child. The administration of anabolic steroids during childhood and adolescence may accelerate sexual and skeletal maturation, and in turn reduce final stature (Johnson and Van de Loo, 2002). Synthetic growth hormone, when administered to short children with growth hormone deficiency, results in small gains in stature. However, the health risks and benefits of giving synthetic growth hormone for short children with normal levels of naturally produced growth hormone are unclear. More importantly, the effects of synthetic hormone on the normal growth hormone production are not known.

While chemical substances have been utilized to accelerate the growth and maturation of young athletes, other more basic methods of manipulation, perhaps, corruption have been used in youth soccer for males. One method used by team managers is the fielding of over-age players to gain an unfair advantage. For example, in the 2001 under-16 Asian youth soccer championship, it was alleged that sixteen of the under 16 players were at least 19 or 20 years old. Hand-wrist radiographs were used to estimate the "ages" of the boys (Sports Illustrated, 2001). The use of hand-wrist radiographs to estimate chronological age in this context has limitations. Boys attain skeletal maturity, on average, by about 18.0 or 19.0 years of age, depending on the method of assessment used (Malina *et al.*, in press). However, one of 10 Mexican youth soccer players (Peña Reyes *et al.*, 1994) and 7 of 43 Portuguese elite youth soccer players (Malina *et al.*, 2000) 15-16 years of age were already skeletally mature, i.e., their estimated ages based on hand-wrist radiographs were 18.0 years. These players would have been eliminated from the competition if their skeletal ages were used, even though their chronological ages based on birth dates were in fact 15 and 16 years! The same trend is also apparent in adolescent ice hockey players (Malina, 1998). This illustrates a major limitation of using radiographs to assess ages of adolescent athletes, and emphasizes the need for accurate birth certificates. The latter, of course, is a problem in areas of the world where birth dates are not systematically recorded. On the other hand, there is also the possibility of team managers, and possibly parents, falsifying birth dates, which has been reported in some youth sport competitions.

A 'win at all costs' approach adopted by some team managers and administrators may carry-over into coaching sessions and create what psychologists have labeled an "ego-involving" or "performance-oriented" climate (Ames, 1992). When an athlete perceives an environment as highly ego-involving, their perception of competence is placed "on the line" each time he/she engages in the activity (i.e., soccer). Accordingly, in such environments continual success is necessary for sustained motivation. Moreover, in order to maintain one's relative standing in competitive settings, individuals may show a lack of concern for justice, fairness, and the welfare of others when ego-involved (Nicholls, 1989). Research conducted with United States Olympic Development youth soccer players suggests that situations perceived as ego-involving are associated with less adaptive types of motivation (Treasure *et al.*, 1999) and lower levels of sportspersonship manifest in a lack of respect for rules, officials, and social conventions (Treasure *et al.*, 1998).

5. PRACTICAL SOLUTIONS

Those involved in the administration of youth soccer programs and talent development often have relatively little or limited understanding of the processes of growth and maturation, their relationships to athletic performance, and their impact on behavior. Coaches and administrators of youth soccer programs need to be aware of the impact of growth and maturation on the physical and psychological development of young athletes. As noted earlier, youth who are extremely early or late in the timing of adolescence need to be reassured that they are normal, i.e., not different from their peers, and that the maturity-related differences in size and athleticism will eventually be reduced and/or eliminated over time. Adolescents are particularly sensitive to the many changes associated with puberty and must learn to deal with them. The coach is in a privileged role of counselor and confidant, and should provide the support and understanding necessary for youth to adjust to the many changes associated with puberty.

Coaches should be aware of the transient nature of the size and performance advantages associated with variation in maturity status during adolescence so that these characteristics should not be as primary factors for selecting players. These strategies typically favor early over late maturing athletes, and may reduce the likelihood that the players with the most potential for success at the highest level of competition will be still be playing soccer or be available for selection in their late adolescent or early adult years (Malina, 2001). Late maturing players need to be given equal opportunity to develop their skills and continue to participate in soccer. More importantly, the long term development of the young athlete should be emphasized rather than the immediate gratification of the coach or parents that is often associated with winning at age group competitions.

The preceding also applies to female soccer players, with perhaps more concern for the skilled early maturing athlete. Changes in physique and body composition during the growth spurt and sexual maturation may influence athletic performance and perceptions of the self. Adolescent girls, particularly those involved in athletics, are very sensitive to changes in body weight and composition. Coaches need to avoid making comments with regards to body weight, especially in cultures or sports where 'thinness' is perceived as being more desirable. Instead, coaches should focus on issues such as health, nutrition, and fitness. Athletes need to be nurtured through these changes in manner that is positive and supportive.

Many soccer programs in the United States have established policies regarding the inclusion and exclusion of young athletes, and equal playing time. Most recreationally-based soccer programs in the United States employ a policy of participation for all. Any child wishing to play soccer is allocated to a team, regardless of their competence. The American Youth Soccer Organization (AYSO) have instituted an "Everyone Plays" rule, requiring each player on a team to play at least one-half of every game. This rule applies to all AYSO teams, (whether regular season teams or teams specially constituted for such event) participating in non-AYSO tournaments or games within or without the U.S.A., regardless of whether the other team, the referee or the sponsors of the tournament or game apply or follow such a rule.

The English Football Association recently implemented changes in the way that young players are grouped for the purpose of talent identification (Simmons and Paull, 2001). A review of the selection criteria for junior squads revealed that many individuals, identified at young ages as having the potential to play at the professional and international, did not make the expected progress. The new strategy for identifying the players with the most potential involved the physical matching of players within selection trials (i.e., players are matched against players of a similar size or physique). Selection was then based upon criteria such as technical skills and tactical awareness. This strategy "...was designed to allow players of more varied physiques to emerge..." on the basis of their skill and tactics (Simmons and Paull, 2001, p. 677), and to provide equal opportunity for players of all shapes and sizes.

To overcome the impact of individual differences in growth and maturation upon the process of inclusion and exclusion in youth soccer, Brewer *et al.* (1995) suggests that soccer associations should establish 'current' and 'potential' squads. Current squads should include the best players, both physically and technically, at the time of the selection trials. Potential squads, in comparison, should contain players that are technically gifted yet lacking in physical development. Such a method would help minimize the impact of age and maturity status upon the process of inclusion of exclusion in youth soccer and would increase the likelihood that talented yet physically less gifted players would remain in the system.

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GROWTH AND MATURITY PROFILE OF YOUTH SWIMMERS IN MEXICO

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1. INTRODUCTION

Sport organization and participation in Mexico has developed considerably since the 1980s. Two factors are have apparently driven this expansion: (1) the assumption that most of the population should have access to sport in any of its different forms (youth sport, popular or recreational sport, and organized sport), and (2) strong interest in improving sport performances at national and international levels, i.e., high performance athletes (CONADE, 1991). In sports such as swimming or diving, opportunities for young participants are often limited due to scarcity of appropriate facilities throughout the country.

Studies of young athletes often focus on the "talented" and in many cases the elite (Malina, 1994, 1998). And, age-group swimmers are well represented among studies of the growth and maturity status of young athletes. Young swimmers are, on average, taller and heavier than reference data for the general population during childhood and adolescence, and in later elite adolescence swimmers tend to especially taller, but not exceptionally heavier. There is, needless to say, variation among studies and geographic regions (Malina, 1994, 1998). The data, however, are primarily available for Europe and the United States. Data for youth swimmers from Latin American countries are limited to reasonably select adolescent samples from Cuba (Alonso, 1986; Pancorbo and Rodriguez, 1986), Brazil (Rocha *et al.*, 1977), and Venezuela (Perez, 1977, 1981), and a sample from the Bolivar Games in 1981 (Brief, 1986). More recently, the anthropometry and somatotype of an international sample of young adult swimmers, including those from Latin America, have been described (Carter and Ackland, 1994).

This paper is considers the growth and skeletal maturity status of youth swimmers from two urban centers in Mexico. They are participants in formal swim programs and are not, as a group, select, talented, or elite level swimmers. The data for this sample of Mexican youth swimmers are then compared to data for youth swimmers of approximately the same age from several Latin American countries.

2. METHODS

The swimmers were part of larger study of the growth and maturity status of youth participants in several sports in different regions of the country in the late 1980s. The cross-sectional sample included 66 males 8.0 to 17.1 years of age and 24 females 8.3 to 14.2 years of age. The swimmers were participants in youth swim programs two urban centers at central and northwestern Mexico. The programs and swimmers are not elite caliber. The children had been training in swimming for periods ranging from six months to two years. Younger children trained twice per week in hourly sessions, while older children trained three times per week in two hour sessions. This study thus provides data on the growth and maturity status of youth enrolled in less formal and less intensive swim programs.

Weight, height, sitting height, and the anthropometric dimensions needed to estimate Heath-Carter somatotype were taken: flexed arm and calf circumferences, bicondylar breadths of the humerus and femur, and the triceps, subscapular, suprailiac and medial calf skinfolds (Carter and Heath, 1990). The body mass index (BMI, kg/m^2) and sitting height/standing height ratio (%) were also calculated.

Hand-wrist radiographs were taken to provide an estimate of skeletal maturity. The Fels method was used to estimate a skeletal age for each child (Roche *et al.*, 1988); Fels assessments were not available for four boys and two girls. The radiographs were assessed by a single, experienced individual (MEPR; Peña Reyes, 1992; Peña Reyes and Malina, 2001).

Chronological age (CA) was subtracted from skeletal age (SA) for each child to provide an estimate of the skeletal maturity status of each swimmer as follows:

Late (delayed) = SA behind CA by more than one year;

Average (on time) = SA within plus or minus one year of CA;

Early (advanced) = SA ahead of CA by more than one year; and

Mature = skeletal maturity (an SA is not assigned).

The cut-off points are arbitrary and a broad range of average ("on time") is preferred to allow for error in the assessments (Malina *et al.*, 2003).

The swimmers were divided into three chronological age groups for comparison. The age groups approximate, in general, those used in swimming competitions. Three groups were so designated in males: 8-10 years (n=20, 8.0-10.9 years), 11-13 years (n=25, 11.1-13.9 years), and 14-17 years (n=21, 14.1-17.1 years). Two groups were designated in females: 8-10 years (n=14, 8.3-10.9 years), and 11-14 years (n=10, 11.0-14.2 years).

Heights and weights of the swimmers were compared to growth charts for American children (Centers for Disease Control and Prevention, 2000). Satisfactory reference data for Mexican children are not available. The reference values commonly used are based on a mixed-longitudinal sample from a private clinical practice in the Federal District in the 1960s and 1970s (Ramos Galvan, 1975), which may not be representative of the Mexican population. The United States reference values are routinely used in growth and nutritional surveys worldwide.

3. RESULTS

Male Swimmers. Descriptive statistics for the three age groups of male swimmers are summarized in Table 1. Mean heights approximate the 25th percentile of United States reference data in the two younger age groups, but is between the 10th and 25th percentiles in the oldest age group. Mean weights, on the other hand, are just below the reference median in the 8-10 and 14-17 year age groups, but close to the 25th percentile in the 11-13 year age group. Swimmers in the two older age groups have, on average, proportionally longer legs than those in the youngest age group, which reflects growth in the lower extremities during the early part of adolescence (note, that the sample includes only few boys in late adolescence which is a period characterized by growth in length of the trunk).

Table 1. Characteristics of male swimmers in three age groups.

	Age Groups					
	8-10 yrs (n=20)		11-13 yrs (n=25)		14-17 yrs (n=21)	
Variable	Mean	SD	Mean	SD	Mean	SD
Age, yrs	9.9	0.8	12.3	0.9	15.7	0.9
Height, cm	134.9	5.0	146.9	9.7	164.6	6.2
Weight, kg	30.3	5.3	38.5	9.1	58.0	9.4
BMI, kg/m^2	16.6	1.9	17.7	2.4	21.3	2.3
Sit Ht/Ht Ratio, %	52.5	1.1	51.7	1.4	51.7	1.2
Endomorphy	2.4	1.0	2.4	1.1	2.5	1.0
Mesomorphy	3.9	1.1	3.8	0.8	4.0	0.8
Ectomorphy	2.8	1.0	3.0	1.1	2.3	1.0

Mean somatotypes of male swimmers show small differences between the two younger age groups, whereas swimmers in the oldest age group slightly more mesomorphic but are especially less ectomorphic (Table 1).

Mesomorphy is the dominant characteristic of swimmers in the three age groups.

Skeletal maturity status of the male swimmers is summarized in Table 2. Mean skeletal age is within plus or minus one year of mean chronological age in the three age groups. Allowing for the relatively small sample sizes, the majority of swimmers in each of the three age groups is classified as average or "on time". Among 8-10 year old, late and early maturing swimmers are are about equally represented. Among 11-13 year old swimmers, 9 are classified as late and only one as early maturing, whereas among 14-17 year old swimmers, 4 are classified as early and 3 are already skeletally mature, and none is classified as late maturing. There thus appears to be a shift towards boys of average and advanced maturity status in the oldest age group of swimmers.

Table 2. Chronological age (CA). Fels skeletal age (SA). and skeletal maturity classification of male swimmers in three age groups.

	CA, yrs		SA, yrs		SA - CA, yrs		Maturity Classification*			
Age group	Mean	SD	Mean	SD	Mean	SD	L	A	E	M
8-10 yrs (n=17)	9.9	0.9	10.3	1.8	0.4	1.8	5	9	3	-
11-13 yrs (n=23)	12.3	0.9	11.7	1.6	-0.6	1.1	9	13	1	-
14-17 yrs (n=21)	15.7	0.9	-	-	-	-	-	14	4	3
Not mature (n=18)	15.6	0.9	16.1	1.3	0.5	1.1				

*Maturity Classification: L=late (delayed), A=average ("on time"), E=early (advanced), M=mature, see text for specific criteria.

Characteristics of 11-13 and 14-17 year old swimmers of contrasting maturity status are summarized in Table 3. Late and average maturing 11-13 year old, and average and early (including the skeletally mature) 14-17 year old swimmers are compared. Numbers in the youngest age group are too small for comparison. Within each age group, the more mature swimmers are taller and heavier, and have a larger BMI. The more mature 11-13 year old swimmers also have proportionally longer lower extremities (lower sitting height/standing height ratio), while the proportional difference is less 14-17 year old swimmers. Late and average maturing 11-13 year old swimmers are, on average, similar in somatotype, whereas the more mature 14-17 year old swimmers are more mesomorphic and especially less ectomorphic.

Female Swimmers. Descriptive statistics for the two age groups of female swimmers are summarized in Table 4. Mean heights and weights of 8-10 year old swimmers fall just below the respective reference medians for American children. In contrast, mean height of swimmers 11-14 years approximates the 10th percentile of the reference, while mean weight is at the 25th percentile of the reference. Swimmers in the older age group have proportionally longer legs than those in the younger age group, which is expected since they are likely in adolescence.

Table 3. Characteristics of male swimmers 11-13 and 14-17 years grouped by maturity status.

	11-13 Years				14-17 Years			
	Late (n=9)		Average (n=13)		Late (n=14)		Average (n=7)	
Characteristic	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CA, yrs	12.0	0.8	12.6	0.9	15.6	1.0	15.8	0.7
SA, yrs	10.3	0.9	12.6	1.2	15.6	1.1	-	-
SA - CA, yrs	-1.7	0.7	0.0	0.5	0.0	0.5	-	-
Height, cm	140.6	4.6	151.6	9.7	163.4	6.2	167.1	5.7
Weight, kg	33.8	4.1	42.0	9.9	55.9	10.3	62.4	5.6
BMI, kg/m2	17.1	1.5	18.1	2.8	20.8	2.6	22.3	1.3
Sit Ht/Ht Ratio, %	52.1	1.4	51.5	1.2	51.8	1.2	51.5	1.2
Endomorphy	2.4	1.0	2.4	1.1	2.5	1.1	2.3	0.7
Mesomorphy	4.0	0.9	3.8	0.9	3.9	0.9	4.3	0.6
Ectomorphy	2.9	0.8	3.0	1.2	2.5	1.1	1.9	0.7

*This group includes three swimmers who are already skeletally mature. They do not differ in age from the four swimmers who are adanced in skeletal age.

Table 4. Characteristics of female swimmers in two age groups.

	Age Groups			
	8-10 yrs (n=14)		11-14 yrs (n=10)	
Variable	Mean	SD	Mean	SD
Age, yrs	9.5	0.7	12.8	1.0
Height, cm	133.8	5.0	147.5	5.4
Weight, kg	29.9	6.0	39.2	5.9
BMI, kg/m^2	16.7	2.9	17.9	1.8
Sit Ht/Ht Ratio, %	53.0	0.8	51.7	1.1
Endomorphy	2.7	1.2	2.8	0.7
Mesomorphy	3.7	0.8	3.5	0.8
Ectomorphy	2.9	1.4	2.9	0.9

Mean somatotypes of female swimmers in the two age groups are virtually identical (Table 4). The somatotype is mesomorphic with balanced contributions of endomorphy and mesomorphy.

Skeletal maturity status of the female swimmers is summarized in Table 5. Mean skeletal age is within plus or minus one year of mean chronological age in the two age groups. Allowing for the relatively small sample sizes, 15 of the total sample of 22 swimmers have skeletal ages that are classified as average or "on time". It is perhaps interesting that none of the 8-10 year old female swimmers are classified as late maturing. Among 11-14 year old female swimmers, all three maturity categories are represented. Note, however, that sample sizes are small, and the suggested trends need to be interpreted with care. Given the small numbers, comparison of female swimmers 11-14 years of age of contrasting maturity status is not warranted.

Table 5. Chronological age (CA), Fels skeletal age (SA), and skeletal maturity classification of female swimmers in two age groups.

	CA, yrs		SA, yrs		SA - CA, yrs		Maturity Classification*			
Age group	Mean	SD	Mean	SD	Mean	SD	L	A	E	M
8-10 yrs (n=12)	9.5	0.7	9.9	8.8	0.4	0.7	-	11	1	-
11-14 yrs (n=10)	12.8	1.0	12.7	2.0	-0.1	1.8	4	4	2	-

*Maturity Classification: L=late (delayed), A=average ("on time"), E=early (advanced), M=mature, see text for specific criteria.

4. DISCUSSION

In contrast to more elite samples of swimmers from United States and Europe, the present sample of swimmers is, on average, shorter and lighter. However, mean somatotypes are reasonably similar to those of other samples of age-group swimmers (Carter and Heath, 1990). Comparative data for body size and somatotype of youth swimmers of both sexes in several Latin American countries are summarized in Table 6.

Table 6. Mean ages. heights. weights. and somatotypes of samples of Latin American youth swimmers.

	n	Age (yrs)	Height (cm)	Weight (kg)	Somatotype* Endo	Meso	Ecto
Males							
This study	20	9.9	134.9	30.3	2.4	3.9	2.8
This study	25	12.3	146.9	38.5	2.4	3.8	3.0
Cuba (a)	14	12.5	149.1	40.7	2.2	4.0	3.3
Venezuela (b)	22	13.8	158.2	46.5	1.8	4.3	3.7
This study	21	15.7	164.6	58.0	2.4	4.0	2.3
Venezuela(b)	17	17.2	175.6	68.0	2.2	4.9	3.0
Females:							
This study	14	9.5	133.8	29.9	2.7	3.7	2.9
Cuba (a)	9	12.5	148.2	42.0	2.8	3.3	2.6
This study	10	12.8	147.5	39.2	2.8	3.5	2.9
Cuba (d)	8	13.2	154.3	47.6	3.0	3.8	2.7
Venezuela (b)	12	13.8	158.2	46.5	2.3	3.8	3.4
Bolivar Games (e)	12	14.5	160.0	54.9	3.4	4.5	2.4
Venezuela (c)	14	14.8	163.7	55.2	3.2	4.1	2.8

*Endo=endomorphy, Meso=mesomorphy, Ecto=ectomorphy

(a) Alonso, 1986; (b) Perez, 1977; (c) Perez, 1981; (d) Pancorbo and Rodriquez, 1986; (e) Brief, 1986

The present samples of male Mexican swimmers 8-10 and 11-13 years of age are, on average, similar in somatotype. The somatotype of male Mexican swimmers 11-13 years (mean age 12.3 years) is similar to that Cuban swimmers of approximately the same mean age (12.5 years, Alonso, 1986), although the Mexican swimmers are slightly shorter and lighter. The older sample of male Mexican swimmers, 14-17 years (mean age 15.7 years), falls between the two Venezuelan samples of more elite status in body size, but is less mesomorphic and particularly less ectomorphic. The younger sample of Venezuelan swimmers is from a private club (Perez, 1977), while the older sample is nationally representative (Perez, 1981).

Female Mexican swimmers 8-10 and 11-14 years of age are, on average, similar in somatotype. The sample of female Mexican swimmers 11-14 years (mean age 12.8 years) is intermediate in body size and somatotype to two samples of Cuban swimmers of approximately the same ages (Alonso, 1986; Pancorbo and Rodriguez, 1986). The older samples of female Latin American youth swimmers are especially more mesomorphic than the female Mexican swimmers. The sample of swimmers from the Bolivar Games of 1981 is most mesomorphic (Brief, 1986), followed by the nationally representative sample of Venezuelan swimmers (Perez, 1981).

Data for more elite samples of European and Australian male age group swimmers indicate skeletal ages (SA) which are concentrated in the average and advanced categories with relatively few late maturing youngsters in late childhood and early adolescence (Malina, 1994). This trend is also apparent in male swimmers at the XII Central American Swimming Championships in 1981 (Peña Reyes *et al.*, 1984). After 14-15 years of age, elite male swimmers from the United States, Belgium, and the Central American Swimming Championships, and a small sample of Olympic swimmers under 18 years of age are advanced in skeletal maturity (Malina, 1994). The data for the present sample of non-elite Mexican males swimmers are generally consistent with these observations on more elite male swimmers, with the exception of the relatively large number of late maturing (n=9) 11-13 year old swimmers. .

The skeletal maturity data for the small sample of Mexican female swimmers is generally consistent with available data for more elite samples. In early adolescence, about 10-13 years, samples of elite female swimmers tend to have skeletal ages that are, on average, appropriate for their respective chronological ages, and most swimmers are classified in the average or "on time" category (Malina, 1994). On the other hand, skeletal ages of female participants 9-14 years of age in the XII Central American Swimming Championships in 1981 tended to be in advance of chronological age; at older adolecent ages, the elite swimmers tended toward late skeletal maturity status (Pena Reyes *et al.*, 1984).

The trends suggested for the skeletal maturity of youth swimmers need to be interpreted with care. The present study used the Fels method of skeletal maturity assessment (Roche *et al.*, 1988). The earlier studies used either the Greulich-Pyle (GP) or Tanner-Whitehouse (TW) methods (Malina, 1994; see also Malina *et al.*, 2003). Systematic comparisons of the methods of assessing skeletal maturity in samples of Mexican children are limited. In a sample of Mexican youth soccer players 7-17 years of age, SA-CA differences with the Fels and Tanner-Whitehouse II (TW II) methods were, on average, reasonably similar in players <11, 11-12, and >15 years of age. However, among players 13-14 years of age, the SA-CA difference was, on average, more than twice as great with the TW II method than with the Fels method. Moreover, six boys were assessed as skeletally mature with the TW II method, while only one boy was assessed skeletally mature with the Fels method (Peña Reyes *et al.*, 1994). Comparison of the Fels and TW II methods in a sample of marginally nourished children 6-13 years of age from an urban colonia (slum) in Oaxaca, southern Mexico, indicated that Fels skeletal ages lagged consistently behind chronological ages more so than TW II skeletal ages in both sexes. However, the heights of the children were more appropriate for Fels skeletal ages than for TW II skeletal ages (Peña Reyes and Malina, 2001).

Although each method of assessing skeletal maturity yields a skeletal age, the skeletal ages are not directly comparable. The three methods of assessment are similar in principle, but differ in criteria for making assessments and procedures used to construct a scale of skeletal maturity from which skeletal ages are assigned. Detailed comparison of the three methods is beyond the scope of this paper. The reader is referred to a more detailed discussion of the three methods, including the most recent revision of the Tanner-Whitehouse method (TW III), in Malina *et al.* (2003). Nevertheless, systematic comparison of the Fels and Tanner-Whitehouse methods in samples of young athletes in different sports and in different countries is needed.

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WORKLOAD AND PERCEPTION OF EFFORT IN SWIM TRAINING

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1. INTRODUCTION

Knowledge of the effects of exercise on the conduction of training is important in reaching desired outcomes, especially when athletes undertake prolonged training loads. Several procedures can be followed to monitor these effects. The usual markers, especially physiological, are often invasive. The stressful character of this methodology, its associated cost, as well as the requirement of laboratories and specialized staff, make them relatively inaccessible to many in the sport community. However, it is possible to register of the subjective perception of effort or fatigue in order to estimate the influence of a specific training load on athletes.

Perception of effort scales were first introduced in cardiac rehabilitation as a way of monitoring the impact of exercises (Borg, 1985, 2000). It is also suggested the perception of effort is the best single indicator since it integrates several sources of information related to the muscles and joints directly involved, and the cardiovascular, respiratory and nervous systems (Borg, 2000). The signs, perceptions and experiences are integrated into a global configuration labeled the perception of effort. These scales have been used to evaluate the fatigue or physiological stress in isolated tasks (Maglischo, 1993; Costil and Wilmore, 1994; Rushal, 1995). The validity of these instruments in activities that involve elevated indices of fatigue makes them very useful in the monitoring of training. Further, the technique involves the athlete as an active agent in the evaluation of effects resulting from the application of specific workloads.

This study evaluates two scales of perception of effort as indicators of accumulated training load in national and regional level competitive swimmers belonging to the same sport clubs and training together. Over the course of 26 weeks of a winter (short season), training load (volume and intensity of weekly training) was monitored in 23 national and 23 regional level swimmers. During each week of the training season, the swimmers recorded their perception of effort in each micro cycle with two scales: the Portuguese version of RTL (Training Load Rating, Berglund and Säfström, 1994), and the Cr10 scale of Borg (1982).

2. THE SUBJECTIVE PERCEPTION OF EFFORT

The intention of detecting and interpreting the sensations produced during physical exercise goes back to the 1950s. Borg (1982, 2000) considered the association between physiological events and the conscientious perception of effort signals in a three-dimensional model. The conceptualization of this model was based on the fact that, with the increase of intensity of exercise, alterations occur in the physiological processes and their perception by the individual. During or soon after an intense bout of physical exercise, the meaning of fatigue and perception of effort are very similar, with the later being related with the concept of intensity of the exercise, although there are important differences between the two concepts.

According to Borg (2000), the three components of the effort (perception, physiological, performance) give partially different information, and the variables concerned are not linearly related. In order to have a valid and complete estimate of the effort of an individual, it is important to integrate information from the three components of the effort.

Perception of effort is the sensation of how heavy and exhausting a physical task is. This definition is basic, but does not offer any measure of the degree of the perceived effort. A measure of perception of effort is then the degree of experienced resistance and tension during physical work that is estimated with a specific classification method. Therefore, it is necessary to quantify the perception of effort, which is not a measure by itself.

2.1. SCALES OF PERCEPTION OF EFFORT

The capacity to evaluate level of effort is highly developed in humans (Borg, 2000; Baron, 2003). The association of sensations provides essential information to determine the degree of well being or level of threat. The perception of the effort is a control behaviour that uses information sources that are necessary to determine attitudes, which lead to the preservation of health and which play an important role in adaptation. Several perception scales have been used to attain this objective (Borg, 2000).

The evaluation of the energy cost of exercise can be made through the use of physiological techniques. However, it is the subjective cost of the exercise that determines if the activity will be continued or not, or if the rhythm of work needs to be increased or reduced. Assessment of subjective sensations is possible only through the use of personal estimates of the intensity of the associated sensations (Nobles and Bruce, 1986; Baron, 2003).

Borg's scale was originally developed with the objective of monitoring perception of effort during cardiac rehabilitation. The initial intention was to construct a scale that reflected the correspondence between the perceived level of effort and cardiac frequency (RPE 6-20). Patients were taught to equate the intensities of work based on cardiac frequency (FC) to values on a subjective scale. The original RPE scale (Rating of Perceived Exertion) was intended to reflect the relationship between the perception of effort and the pulse rate, a linear relationship between cardiac frequency and exercise intensity. The scale extended from 6 (no sensation) to 20 (maximum effort). It was soon realized that the RPE 6-20 scale was not appropriate for studies that involved the associated sensation of physiological variables, such as lactate accumulation, whose behaviours are not linearly related with intensity of the exercise (Noble and Robertson, 1996).

A new scale of 10 was later introduced. It was better adjusted to the subjective sensations of physical tasks and is known as Cr10 (Category Ratio scale, Borg, 1982). Zero refers to the total absence of sensation and 0,5 to slightly perceivable sensation. The category of maximum was placed beyond 10 (extremely difficult), after noting that athletes tended to never use this category (Noble and Robertson, 1996). Borg (2000) also reported a high correlation between the new scale and blood and muscle lactate levels.

0 – Nothing at all
0.5 – Extremely weak
1 – Very weak
2 – Weak (light)
3 - Moderate
4 – Somewhat strong
5 – Strong (heavy)
6 -
7 – Very strong
8 -
9 -
10 – Extremely strong (almost max)
• - Maximal

Figure 1 Borg's Cr10 scale (adapted from Noble and Robertson, 1996).

Maglischo (1993) applied identical procedures with swimmers in an attempt to have them use the scales to monitor the intensity of training. One of the main advantages of using the scale was the fact that it was possible for the swimmers to progress in intensity of training not as a function of pre-set plans, but as a function of their perception of present capacity. The main disadvantage was a lack of quantification of intensities of training.

Maglischo (1993) related perception of effort determined by the Cr10 scale with different levels of intensity of swim training (Table 1). Bergglund and Säfström (1994) used another scale to identify perceived effort - the Rating of Weekly Training Load - RTL (Figure 2), and included a measure of psychological effects of training. In a study of 14 elite canoeists, 9 men and 5 women, there was a linear relationship between the RTL and the Profiling of Mood States questionnaire (POMS, Macnair, 1992). The proposed RTL scale ranged from 0 (rest) to 16 (very, very difficult).

Table 1. Borg's Cr10 in relation to possible training effects and level of training (adapted from Maglischo. 1993)

Rating scale	Perceived Effort	Possible Training Effects	Level of Training
10	Extremely difficult	Improves anaerobic metabolism	Lactate tolerance
9	Very difficult	Improves anaerobic capacity anaerobic and VO_2 max; intensity is above the present anaerobic threshold	Lactate tolerance End-3
7-8	Hard but manageable	Overloads aerobic metabolism; work at or slightly bellow the present anaerobic threshold	End-2
5-6	Moderate effort	Improves aerobic capacity. while providing some relief from intense training	End-1
3-4	Easy	Maintains aerobic endurance while recovering from intense training	End-1
1-2	Very Easy	Is useful for warming up and swimming down	

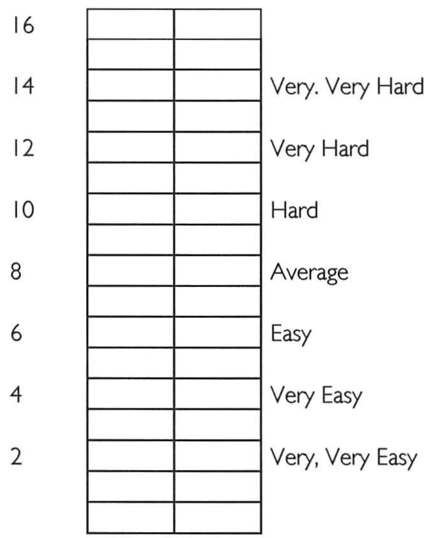

Figure 2 Rating of weekly training load (*RTL) scale* (adapted from Berglund and Säfstrom, 1994)

2.2. FACTORS THAT INFLUENCE SUBJECTIVE PERCEPTION OF EFFORT

Perception of effort depends on the type of exercise and specific muscular work (Ben Sira, 1986) The relationship between increased perception of effort and duration of the exercise is well established. There is a difference in the perception of effort between short and long duration exercises. In the first case, the individual tends to evaluate his effort in relation to his maximum capacity, while in the second case the individual might evaluate his effort with the objective of maintaining a particular level of effort during a greater period of time (Ben Sira, 1986). When comparing equal productions of work, perceived effort is greater in low frequency/high resistance activities compared high frequency/low resistance activities (Mihevic, 1981)

With training adaptation, athletes tend to show lower levels of perceived effort for the same workload. There is some speculation about possible differences between men and women on the perception of effort. It has also been observed that, for the same type of physical task, women significantly classify the effort as heavier than men. The perception of effort and possible variations do not depend only on the intensity, duration and volume of the exercise, physical factors, and the environment and/or context, but also on psychological factors. Factors related to motivation, emotional state and personality may also influence perception of effort. Highly motivated individuals (e.g., former athletes) tend to underestimate perception of effort. Emotional factors or temporary mood states (depression, anxiety, anger, joy) also influence the perception of effort.

3. SAMPLE

The sample inlcuded 46 swimmers, 23 of each gender, from sport clubs of the same regional swimming association. The mean age for the total sample was16.6±1.8 years, 17.5± 1.9 years in males and 15.7±1.3 years in females. The swimmers represented two competitive levels, 23 national swimmers with access to the Portuguese National Championships and 23 regional level swimmers. The age composition of the sample was primarily 16 to18 years (74%), which reflected the distribution of registered swimmers in the geographic area in which the study was conducted. All swimmers were informed of the objectives and procedures of the study and gave their written consent. In the case of younger athletes, written consent was given by their parents.

Table 2. Characteristics of the sample by age, sex and level of competition.

Age - group	National		Regional		Total
	Male	Female	Male	Female	
14-15		3		5	8
16-18	12	6	7	9	34
19-24	2		2		4
Total	14	9	9	14	46

Table 3. Body weight, stature and arm span by sex and level of competition (mean ± standard deviation).

	National		Regional	
	Female	Male	Female	Male
Weight, kg	59.3 ± 6.8	63.2 ± 5.7	51.5 ± 5.8	68.5 ± 10.5
Height, cm	165.8 ± 4.5	170.3 ± 4.8	158.9 ± 6.6	173.2 ± 6.8
Arm span, cm	165.4 ± 6.6	176.1 ± 4.9	159.8 ± 7.3	179.7 ± 8.1

4. METHODS

All of the participants registered their level of perception of effort in a tabular calendar using the two scales mentioned indicated earlier. Entries were made at the beginning of each week, using the previous week as a reference. The beginning of the study was coincident with the first week of the season in September and ended after the main competition of the short season in March, for a total of 26 weeks. Although use of the scales was sufficiently simple, the swimmers had some initial difficulties in faithfully expressing their perception of effort.

Months	Set				Oct				Nov				Dec				Jan				Feb				Mar				
Training Phase	Basic preparatory									Specific								Competitive											
Competitions										TRF				CNPC						T E		TNC		CRPC			CNPL	
Weeks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	

Figure 3. Tabular calendar used in the study

The swimmers were asked to adopt the following procedure. First, to look at the description that most closely matched the level of perception of effort of the last week of training, and to quantify this sensation. Several basic points need to be taken into consideration to use the scale correctly (Noble and Robertson, 1996):

1. To define perception of effort;
2. To be able to link the category of sensation to the associated value;
3. To explain the nature and use of the scale;
4. To explain that the perception can be localised or global depending on the objective of the study;
5. To be as honest as possible;

Records were checked weekly to see if the process was done correctly. The daily workload was also registered.

QUANTIFICATION OF TRAINING LOAD

The use of the total distance swam does not clearly reflect the physiological stress produced at different levels of intensity (Sharp, 1993). Training load was determined through the total amount of meters swam (volume) and also by the balance of the distance completed at each level of intensity (Mujika *et al.*,1995; Navarro, 2001; Chatard and Mujika 1999). The use of indices of difficulty has been established in reference to the probable values of blood lactate accumulation normally associated with the different tasks of swimming training. Factors of intensity 1, 2, 3, 4, 6, 8 and 10 were matched with the volume done in each zone of intensity (I,II, III, IV, V, VI and VII). The magnitude of the load was then expressed in dimensionless units of load, or arbitrary units of load (AUL), quantified from the obtained rate of the sum of the volumes swam in each of the weighed zones multiplied by the respective index and the total volume effectively completed. This procedure allows adjustment to the exponential function determined by the curve of lactate accumulation in relation to the intensity of a swim.

Table 4. Intensity levels, objectives, average velocity on tasks, probable lactate, and stress indices for swim training

Intensity Level	Objective	Average velocity	Lactate $mmol.l^{-1}$	stress indices
I	Warm-up and swim down	under 60%	-	1
II	Aerobic capacity	60 - 70%	2 - 3	2
III	Anaerobic Threshold	≈ 80%	3 - 4	3
IV	Misted	≈ 85%	6 - 9	4
V	Lactate Tolerance	≈ 90%	>8	6
VI	Lactate Production	≈ 95%	>8	8
VII	Sprint	maximal	-	10

The micro cycle or weekly load is quantified by two factors: *volume* - total of meters swam, and *intensity* determined through the sum of the resulting dimensionless units of load of each session of training.

5. RESULTS

5.1. TRAINING LOAD

Because both regional and national level swimmers trained together it was important to verify if the training load between the two groups was indeed different or if the competitive level attained was due to other factors such as talent. The values of the training load show great variability due to the heterogeneous weekly training frequency of the two groups of swimmers. The national group had a weekly minimum frequency of five training sessions, and this criterion was fulfilled by all of the swimmers with few exceptions associated with injury or illness. The national level sample swam, on average, 27.7±4.3 km per week, and a total of 728.5±132.7 km (Table 5). Intensity (weighed volume for intensity zone) corresponded to a weekly mean of 14.3± 4.3 AUL and a total mean of 377.3±122.9 AUL. Corresponding values for regional level swimmers followed a similar pattern, on average, for the season: weekly volume, 24.2±5.4 km; total volume, 626.1±157.1 km, intensity, 12.5±3.9 AUL; and total intensity, 324.8±109.8 AUL.

Table 5. Means, standard deviations and Student-t tests for training variables by level of competition: week volume, total volume, mean week intensity and sum of AUL.

	Level	Mean ± sd	t	p
Week Volume, m	National Regional	27,742 ± 4,270 24,170 ± 5,357	2.50	≤0.05
Total Volume, m	National Regional	728,470 ± 132,722 626,053 ± 157,124	2.39	≤0.05
Intensity, AUL	National Regional	14.3 ± 4.3 12.5 ± 3.9	1.94	n.s.
Σ of AUL	National Regional	377.3 ± 122.9 324.8 ± 109.8	1.53	n.s.

The volumes of national level swimmers are significantly (p≤0.05) higher than those of regional level swimmers (Table 5). When the workload was compared by specific weeks, differences were significant in seven weeks (Table 6). The overall differences in mean weekly intensity and mean total sum of intensity between national and regional swimmers, though higher in the former) are not significant (Table 5). However, mean weekly intensities differ significantly (p≤0.05) in eight weeks (Table 7). It seems that the training load fulfilled by the two groups of swimmers differed in the amount of meters swam. Regional swimmers, although fulfilling fewer kilometres, seem to dedicate more attention to tasks of higher intensity, trying to overcome insufficient exposure to the load. The criterion intensity (AUL), which express meters swam, weighted according to level of intensity, does not allow for the discrimination of workload between the two groups of swimmers. Nevertheless, the national group fulfilled a greater volume in high intensity levels (14.3±4.3 AUL) compared to regional swimmers (12.5±3.9 AUL).

Table 6. Means and standard deviations of volume (m) and Student-t tests for the weeks with a statistical significance between the national and regional swimmers.

	Level	Mean ± sd	t	p
VOL9	National Regional	32,519 ± 7,821 26,605 ± 7,550	2.609	$\leq$0.05
VOL11	National Regional	21,547 ± 5,009 18,025 ± 5,380	2.298	$\leq$0.05
VOL15	National Regional	36,730 ± 9,030 26,252 ± 10,838	3.495	$\leq$0.01
VOL16	National Regional	29,105 ± 9,808 22,053 ± 8,424	2.403	$\leq$0.05
VOL18	National Regional	34,359 ± 6,227 26,388 ± 9,138	3.405	$\leq$0.01
VOL21	National Regional	31,704 ± 8,529 23,917 ± 10,611	2.743	$\leq$0.01
VOL24	National Regional	29,404 ± 6,116 25,309 ± 5,567	2.375	$\leq$0.05

Table 7. Means and standard deviations for intensity (AUL) and Student-t tests for weeks with a statistical significance between national and regional swimmers.

	Level	Mean ± sd	t	p
INT9	National Regional	17.3 ± 4.6 14.2 ± 5.1	2.16	$\leq$0.05
INT11	National Regional	12.9 ± 4.6 10.0 ± 3.7	2.29	$\leq$0.05
INT13	National Regional	14.9 ± 5.2 11.4 ± 5.7	2.19	$\leq$0.05
INT15	National Regional	17.6 ± 5.6 12.7 ± 5.6	2.86	$\leq$0.01
INT16	National Regional	14.7 ± 7.2 10.4 ± 4.9	2.16	$\leq$0.05
INT18	National Regional	18.2 ± 5.5 14.8 ± 5.9	2.01	$\leq$0.05
INT19	National Regional	15.1 ± 5.8 11.2 ± 5.4	2.38	$\leq$0.05
INT21	National Regional	14.2 ± 5.3 10.9 ± 5.8	2.02	$\leq$0.05

5.2. EFFORT PERCEPTION

There were no significant differences in perceived effort between male and female swimmers. Hence, the data are reported for the sexes combined.

5.2.1. Perception of effort using the RTL scale

Data for the perception of effort was analysed from the second week of training onward because some athletes initiated the season later and/or showed some initial difficulties in recording perception of effort. The lowest value of perception of effort, independently of the scale used, occurred in the beginning or at the end of the season. This behaviour was expected, since the athletes had just returned from holidays and the initial approach to training was made very slowly. The last week of the study corresponded to a period of recovery after the most important event of the season.

Table 8. Means, standard deviations and significant Student-t tests for perception of effort using the RTL scale in regional and national swimmers.

	Level	Mean ± sd	t	p
RTL9	National	9.77 + 1.74	2.25	$\leq$0.05
	Regional	8.68 + 1.46		
RTL14	National	9.45 + 1.87	2.29	$\leq$0.05
	Regional	8.05 + 2.19		
RTL22	National	10.05 + 1.80	3.65	$\leq$0.01
	Regional	8.00 + 1.88		
RTL23	National	10.23 + 1.77	2.99	$\leq$0.01
	Regional	8.22 + 2.63		
RTL24	National	11.14 + 3.21	2.75	$\leq$0.01
	Regional	8.65 + 2.84		
RTL25	National	10.30 + 2.30	4.27	$\leq$0.01
	Regional	7.83 + 1.56		
RTL26	National	9.30 + 2.42	3.03	$\leq$0.01
	Regional	7.28 + 1.67		

As shown in Table 8, national swimmers recorded the highest mean of perceived effort in the 24th week of the season (11.1±3.2). The lowest mean, 6.6±2.4, was recorded in the 2nd week of training. Looking at the highest value for the perception of effort and training workload, week 24 had a mean volume of 29403±6116 km. Looking at intensity, this week was the second in a cycle of great intensity (17.2±5.4 AUL). For regional swimmers, the highest value for perception of effort was recorded in the 7th week (9.6±2.3) and the lowest was recorded in the first week of the study (5.3±2.4). Considering the dynamics of the training load of this group, the 7th week corresponded to the week following the micro cycle which registered the highest values for volume and intensity. The slightly dislocated temporal coincidence can be explained by a process of insufficient recovery in the subjective perception of effort and by mechanisms of accumulated fatigue.

The analysis of mean values for perception of effort shows that, at all times, national level swimmers presented higher mean scores than regional swimmers. Differences in perception of effort using the RTL scale between national and regional level swimmers were significant ($p \leq 0.05$) in weeks 9, 14, 22, 23, 24, 25 and 26. These weeks corresponded to moments of increasing training load determined by the increase of intensity or volume. However, when analysing the temporal coincidence of training load and perception of effort, only at weeks 22 and 25 were the differences in perception of effort coincident with differences in volume swam by the two groups. This occurred for intensity only at week 9.

It seems that the swimmers, independently of competitive level, perceived the effort of the training tasks without isolating them from their daily activities. Factors such as the presence or lack of competitions, school obligations, social relationships, and others, may contribute to the perception of effort.

Table 9. Means, standard deviations and significant Student-t tests for perception of effort using the Cr10 scale in regional and national swimmers.

	Level	Mean ± sd	t	p
Cr10 15	National Regional	4.30 ± 1.83 3.71 ± 1.35	2.425	≤0.01
Cr10 17	National Regional	5.13 ± 2.24 4.03 ± 1.38	2.076	≤0.05
Cr10 23	National Regional	5.64 ± 1.68 3.59 ± 1.65	4.403	≤0.01
Cr10 24	National Regional	6.27 ± 2.69 4.09 ± 2.15	4.075	≤0.01
Cr10 25	National Regional	5.04 ± 2.18 3.52 ± 1.12	3.015	≤0.01
Cr10 26	National Regional	4.72 ± 2.20 3.06 ± 1.30	2.972	≤0.01
Cr10 27	National Regional	2.95 ± 1.35 2.07 ± 1.02	2.366	≤0.05

5.2.2. Perception of Effort from CR10 Scale

National level swimmers scored the highest values on the Cr10 scale in week 24 (6.3±2.7), and the lowest score at the beginning of the season (2.4±1.3). The 24th week coincided with period of important volume and the intense participation in competition. Regional level swimmers recorded the highest score for perceived effort with the Cr10 scale was in the 7th week (4.7±2.0) and the lowest at the beginning of the study (1.9±1.3). Consistent with results for the RTL scale, the 7th week was the week with the highest mean volume done by this group.

5.2.3. Behaviour of the Sample Relative to Scale of Perception of Effort Used

The analysis of Table 10 shows in a consistent manner that national level swimmers recorded greater perception of the effort than regional swimmers. This helps to confirm the potential of these instruments in discriminating between athletes in the same sport who have different levels of participation. Analysis of mean values for perception of effort with both scales showed significant differences by level of swimming competition.

Table 10. Means, standard deviations and Student-t tests for perception of effort using the RTL and Cr10 scales with regional and national swimmers.

	Level	N	Mean ± sd	t	p
CR10	National	23	4.25 ± 0.99	3.293	≤0.01
	Regional	23	3.57 ± 0.76		
RTL	National	23	9.09 ± 0.88	3.725	≤0.01
	Regional	23	8.05 ± 1.01		

The values of perception of effort over the 26 weeks of the study with the RTL scale showed a higher mean for national (9.1±0.9) than for regional (8.0±1.0) swimmers ($p \leq 0.01$). The mean value of national level swimmers with the RTL scale fell between the "average" and "hard" categories, while that of regional swimmers fell in the "average" category.

With the Cr10 scale, the mean value for perception of effort for national swimmers was 4.3±1.0, which corresponded to the "somewhat strong" category. The mean value for regional swimmers was 3.6±0.8, which corresponded to the "moderate" and "somewhat strong" categories. The difference between groups of swimmers was significant ($p \leq 0.01$). This result may be related to several factors, such as more demanding training in volume and intensity, as well as participation in competitions of greater significance.

Only during one of the 26 weeks of the season was a maximum mean value of 10.5±2.5 recorded, which corresponded to a perception of the effort between "hard" and "very hard" for national swimmers, while the regional group recorded a maximum mean of 9.6±2.3, which was anchored in the "hard" category. As noted by Borg (2000), athletes tend to underestimate their perception of effort. It is thus possible that throughout the season, the natural adaptation to the training tasks can lead to a disregard of the difficulty of the workloads.

Table11. Means and standard deviations for perception of effort with the RTL and Cr10 scales by age group.

	Age-Group	N	Mean ± sd
RTL	14-15	9	8.84 ± 0.62
	16-18	33	8.60 ± 1.07
	19-24	4	7.68 ± 1.68
	Total	46	8.57 ± 1.08
Cr10	14-15	9	3.43 ± 0.66
	16-18	33	4.23 ± 0.94
	19-24	4	3.40 ± 1.22
	Total	46	3.40 ± 0.97

Although numbers were small in some age groups, there were not significant differences in perception of effort by age within each sex (Table 11). And as noted earlier, males and females did not differ significantly in perception of effort on either scale. However, the difference with the Cr10 scale approached significance (Table 12).

Table 12. Means and standard deviations for perception of effort with the RTL and Cr10 scales by sex.

		N	Mean ± sd	t	df	p
CR10	Male	23	4.26 ± 1.01	1.858	44	n.s.
	Female	23	3.74 ± 0.88			
RTL	Male	23	8.70 ± 1.21	0.84	44	n.s.
	Female	23	8.44 ± 0.94			

5.3. CORRELATIONAL ANALYSIS

Correlations among variables are summarized in Table 13. The two scales of perception of effort are highly correlated, $r=0.95$ ($p \leq 0.01$). Training load components are also strongly correlated with perception of effort as assessed by both scales. Correlations for volume were $r=0,84$ and $r=0.85$ ($p \leq 0.01$), respectively, for the Cr10 and RTL scales. Corresponding correlations for intensity were, respectively, $r=0.73$ and $r=0.71$ ($p \leq 0.01$) for the Cr10 and RTL scales.

Table 13. Person's correlation coefficient for the perception of effort determined for the RTL and Cr10 scales and workload - volume (km) and intensity (AUL)

		RTL	Volume	Intensity
	Cr10	0.95**	0.84**	0.73**
	RTL		0.85**	0.71**

** p< 0.01

6. CONCLUSION

The results highlight the validity of using scales of perception of effort to monitor and control training. Higher values of perceived effort in national level swimmers, who had higher training loads, were observed.

Although the majority of this sample was 16 to 18 years, age did not seem to influence perception of effort scores. This may partially be explained by the adoption of similar training loads by all age groups. Sex differences in perception of effort were not significant, which may also be explained by the adoption of similar training loads by male and female swimmers. This is generally a characteristic of training among swimmers. There may be sex differences in sports with a greater variability of tasks and training intensities.

Perceived effort differs between the two performance levels during a period when participation in competition is more frequent, i.e., the last 6 to 7 weeks. It appears that perception of effort is affected by participation in competitions and/or the approach of important competitions.

The results suggest that the use of perception of effort scales can function as auxiliary instruments to monitor the training process in swimming. The scales correlate strongly with the volume and intensity of training load. Both scales (CR10 and RTL) have similar potential to function as instruments to help monitor and control the training process in swimming.

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PHYSIOLOGICAL AND FUNCTIONAL CHARACTERISTICS OF ADOLESCENT ATHLETES IN SEVERAL SPORTS: IMPLICATIONS FOR TALENT IDENTIFICATION

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1. INTRODUCTION

The body size and composition of adolescent athletes receive considerable attention in discussions of adolescent athletes in a variety of sports. Of equal and perhaps more importance are functional and physiological characteristics associated with, on one hand, muscular strength, power and endurance, and on the other hand, aerobic and anaerobic capacities. These characteristics are often included in inventories aimed at identifying potentially talented young athletes in many sports. The identification process is influenced, of course, by the course of normal growth and maturation which are highly individual processes. As a result, there is considerably inter-individual variation, especially during the adolescent growth spurt. Likewise, there is considerable variation in the responsiveness to training, i.e., trainability, during adolescence. In later adolescence, adult size is almost attained, whereas functional variables continue to develop. Hence, it is appropriate to consider the physiological characteristics of late adolescent athletes. This paper thus presents a profile of the body size, composition and physiological characteristics of elite late adolescent athletes in a variety of sports.

2. METHODS

2.1. Subjects

The subjects were top Czech athletes of both sexes, 249 males and 146 females, in nine sports: triathlon, long and middle distance running, cross-country skiing, cycling, soccer, basketball, canoeing, swimming. All subjects trained at least 6 days a week and had been engaged in high-intensity training for at least 5 years. The mean time spent in intensive training was about two hours per session. The best of the athletes competed regularly at international events and were successful in European and/or World junior Championships. As a group, the sample can be labelled as including the best, young Czech athletes.

2.2. Methods

Height and weight were measured. Body composition was estimated with whole-body impedance using a commercially available bio-impedance system (BIA 2000-M). A tetrapolar electrode configuration with the subject in a supine position on the right hand and foot in positions which are recommended by producer. Prior to positioning the electrodes, each site was prepared by swabbing with alcohol and then allowed to dry. A current of 400 μA at frequencies 1, 5, 50, and 100 kHz was introduced to the subject. Capacitance and resistance (angle between these variables) from whole impedance were used to derive estimates of extra-cellular mass (ECM) and body cell mass (BCM). The ratio of ECM to BCM was used as an estimate of muscle mass.

An incremental exercise test to subjective exhaustion on a treadmill at 5% inclination was used to estimate oxygen uptake and VO_2max. The initial speed of running ranged from 9 $km.h^{-1}$ to 13 $km.h^{-1}$ depending on the speed predisposition of the subjects. The running speed was increased each minute by 1 $km.h^{-1}$ until subjective exhaustion. Heart rate was monitored by means of short-range radio telemetry (Sporttester, Polar). The computer printed out these values every 30 s. The maximal value was defined as the mean of the two highest consecutive values.

Respiratory variables and gas exchange were measured using an open system. The athletes breathed through a two-way valve with a small dead space (Jaeger or TEEM 100). Pulmonary ventilation was measured using a pneumotachograph (Jaeger or TEMM 100) calibrated before and after each test by a mechanical pump. The oxygen concentration was measured using a paramagnetic analyser and the CO_2 concentration using an infrared analyser (both Jaeger). Both analysers were calibrated throughout the physiological range of measurement using gases of known concentration. Both instruments were compared and the differences between the data determined by both were less than 1.5%.

The coefficients of energy cost of running were calculated from the maximal intensity of exercise where a reliable relationship between the intensity of exercise and the energy expenditure was still observed. This corresponds to the anaerobic threshold, in the present study the ventilatory threshold (VT). Although many non-invasive methods may be used, a non-linear increase in pulmonary ventilation with respect of VO_2 or VCO_2 is at present the simplest, and probably the most accurate method for determining the VT. The criterion for VT determination was a non-linear increase in pulmonary ventilation versus VO_2 or VCO_2 (Bunc *et al.*, 1987). The ventilatory threshold was assessed by means of a two-compartment linear model using these relationships. This was done with a computer algorithm to establish a two-line regression intersection point .

Blood lactate concentration was measured in the third minute after finishing the exercise from samples of arterialized blood collected from the finger tip. The enzymatic method (Boehringer kits) was used to analyse the blood sample.

3. RESULTS

Descriptive statistics for age, height, weight and estimated body composition are summarized by sport for male and females athletess, respectively, in Tables 1 and 2. With the exception of basketball players (196.1 cm) followed by swimmers (182.3 cm), mean heights of male athletes in the other sports vary within a relatively narrow range, 176.8 cm to 180.6 cm. Mean weights of male athletes are more variable, ranging from 63.09 kg for long distance runners to 85.4 kg for basketball players. In contrast to body weight, estimated relative fatness and the ratio of ECM/BCM, on average, fluctuate within a relatively narrow range.

Table 1. Means and standard deviations for age and physical characteristics of late adolescent male athletes.

Sport	n	age (years)		mass (kg)		height (cm)		%fat		ECM/BCM	
Triathlon	58	17.3	1.8	69.5	6.9	179.6	4.1	10.4	2.2	0.72	0.06
L.D. running	29	17.0	0.8	63.9	4.9	178.1	4.5	8.0	1.9	0.71	0.07
M.D. running	35	17.4	1.1	66.2	4.1	179.5	4.0	9.0	2.0	0.70	0.09
C.C. skiing	28	17.3	0.8	67.5	4.1	176.8	3.4	8.1	3.0	0.71	0.08
Biathloni	56	17.4	0.7	68.2	3.8	179.3	3.2	9.4	-2.7	0.72	0.07
Cycling	15	17.5	0.6	65.9	3.1	177.0	3.0	8.6	1.4	0.72	0.08
Soccer	32	16.9	1.2	70.9	3.0	180.6	2.1	9.6	1.2	0.74	0.07
Basketball	17	17.4	0.9	85.4	2.9	196.1	4.2	11.9	1.6	0.78	0.10
Squash	16	16.8	1.8	66.5	3.0	178.5	.5	9.7	2.1	0.76	0.08
Tennis	12	16.9	1.5	68.5	2.7	179.1	3.7	10.2	2.2	0.77	0.09
Canoeing	21	17.4	0.8	74.5	5.1	179.5	4.6	11.4	1.9	0.70	0.06
Swimming	14	17.3	0.9	73.6	3.5	182.3	3.2	12.0	2.4	0.73	0.11

The distribution of mean heights of female athletes is similar to that of male athletes. Basketball players are, on average, tallest (183.1 cm), whereas the heights of athletes in other sports vary within a relatively narrow range, 167.3 cm for long distance runners to 172.6 cm for swimmers. The mean height of the small sample of female soccer players, 165.3 cm, appears to be an exception. Mean weights of female athletes are a bit more variable, 56.3 kg in soccer players to 65.7 kg in canoeists. The range of estimated relative fatness and ECM/BCM in female athletes is greater than the corresponding range in males. The estimated fatness of female athletes was greater than in male athletes in the same sport.

Table 2. Means and standard deviations for age and physical characteristics of late adolescent female athletes.

Sport	n	age (years)		mass (kg)		height (cm)		%fat		ECM/BCM	
Triathlon	39	17.1	1.1	61.3	3.6	169.3	2.0	12.5	1.9	0.74	0.08
L.D. running	12	17.1	0.9	56.8	1.9	167.3	2.1	9.4	1.3	0.73	0.10
M.D. running	18	17.2	1.0	57.3	2.2	169.5	2.4	10.3	2.0	0.72	0.09
C.C. skiing	16	17.4	1.1	59.2	1.9	171.2	2.1	9.5	1.4	0.72	0.08
Biathlon	41	17.2	0.8	61.3	1.7	171.8	1.8	10.6	1.5	0.73	0.09
Cycling	11	17.1	0.8	57.4	2.4	168.3	1.9	11.1	1.7	0.74	0.09
Soccer	10	16.9	0.7	56.3	2.1	165.3	1.7	13.0	1.9	0.80	0.08
Basketball	12	17.0	0.8	72.3	2.6	183.1	1.9	14.2	2.1	0.83	0.07
Squash	14	16.3	0.8	57.4	5.0	167.2	4.0	14.5	2.0	0.86	0.10
Tennis	11	16.5	0.9	58.5	4.0	168.1	3.6	14.7	2.2	0.87	0.08
Canoeing	15	16.5	0.8	65.7	5.2	172.3	4.1	12.8	1.6	0.76	0.08
Swimming	13	17.2	1.1	64.8	2.5	172.6	2.0	13.9	1.9	0.75	0.10

The profiles of maximal functional variables for male and female athletes are summarized in Tables 3 and 4, respectively, both groups of young athletes. There are small and non-significant differences in maximal oxygen uptake among endurance athletes of both sexes (triathlon, cross country skiing, long and middle distance runners, cyclists), whereas maximal oxygen uptake of endurance athletes is, on average, greater than in swimmers and team sport athletes.

Table 3. Means and standards deviation of selected maximal functional variables based on treadmill ergometry (%5 slope) in late adolescent male athletes.

Sport	n	$VO_{2max}.kg^{-1}$ (ml)		V_{max} ($l.min^{-1}$)		v_{max} ($km.h^{-1}$)		LA_{max} ($mmol.l^{-1}$)	
Triathlon	58	71.9	5.9	137.6	15.7	18.8	1.3	12.8	2.1
L.D. running	29	74.8	3.6	121.6	12.4	19.0	0.8	12.6	1.8
M.D. running	35	69.7	4.5	138.7	16.7	19.1	0.9	13.4	2.0
C.C. skiing	28	76.9	2.3	147.1	8.9	19.6	0.5	13.6	1.4
Biathlon	56	75.3	2.7	145.5	9.1	18.8	0.6	13.5	1.6
Cycling	15	68.4	5.2	132.3	19.6	18.1	0.7	13.3	1.7
Soccer	32	60.9	2.9	127.5	9.6	17.6	0.7	12.6	1.9
Basketball	17	56.2	1.9	142.5	10.4	16.8	0.9	12.4	1.6
Squash	16	58.9	8.5	106.2	12.8	17.0	0.9	13.4	0.8
Tennis	12	57.5	5.2	109.5	9.6	16.5	0.8	13.1	1.2
Canoeing	21	62.2	3.0	137.4	18.1	17.8	0.8	12.9	1.2
Swimming	14	63.5	3.1	148.6	18.7	17.5	0.8	11.8	2.4

Table 4. Means and standard deviations of selected maximal functional variables based on treadmill ergometry (%5 slope) in late adolescent female athletes.

Sport	n	VO2max.kg-1 (ml)		Vmax (l.min-1)		vmax ($km.h^{-1}$)		LA_{max} ($mmol.l^{-1}$)	
Triathlon	39	61.9	2.4	126.6	13.0	15.7	0.6	12.7	1.2
L.D. running	12	65.7	2.6	119.3	12.4	16.4	0.6	12.5	1.6
M.D. running	18	62.3	2.1	118.6	12.7	16.4	0.8	13.7	2.4
C.C. skiing	16	66.5	2.3	119.1	8.6	16.3	0.9	13.3	2.0
Biathlon	41	64.7	2.0	117.5	9.1	16.0	0.9	13.0	1.8
Cycling	11	59.8	2.0	116.2	12.9	15.4	0.8	12.9	1.8
Soccer	10	50.6	1.6	94.1	7.8	14.7	0.6	12.1	1.2
Basketball	12	48.9	1.8	109.5	6.4	14.3	0.7	12.0	1.8
Squash	14	53.4	5.7	86.8	6.0	14.5	0.9	13.0	0.7
Tennis	11	52.9	3.2	90.8	8.4	14.3	0.8	13.1	1.0
Canoeing	15	51.8	2.3	120.3	11.8	15.6	0.9	13.0	1.6
Swimming	13	57.9	2.2	133.4	14.8	15.2	0.5	11.7	2.4

Table 5. Means and standard deviations for selected functional variables at VT and the coefficient of energy cost of running (C. with treadmill with slope of 5%) in late adolescent male athletes.

Sport	n	VO2.kg-1 (ml)		%VO2max.kg-1		V (km.h-1)		%vmax		C (J.kg-1.m-1)	
Triathlon	58	59.5	4.9	82.7	2.1	15.4	1.5	81.9	2.6	3.74	0.13
L.D. running	29	62.8	4.5	83.9	2.9	16.1	1.8	84.7	2.3	3.70	0.11
M.D. running	35	57.8	4.2	82.9	2.7	16.2	2.0	84.9	2.0	3.69	0.10
C.C. skiing	28	64.4	2.8	83.7	1.9	15.8	0.7	80.6	1.1	3.74	0.09
Biathlon	56	62.4	2.1	82.8	1.6	15.1	0.6	80.3	1.0	3.75	0.09
Cycling	15	57.0	5.1	83.3	2.3	14.9	1.2	82.5	2.9	3.80	0.12
Soccer	32	48.6	3.1	79.8	2.6	13.8	0.9	80.4	1.6	3.76	0.10
Basketball	17	44.2	1.0	78.6	2.0	12.8	0.8	76.3	2.0	3.90	0.11
Squash	16	46.6	1.9	79.2	1.6	13.4	0.5	78.8	2.3	3.84	0.12
Tennis	12	45.2	2.1	78.6	2.4	13.2	0.6	80.0	2.1	3.87	0.10
Canoeing	21	49.4	3.1	78.9	2.0	14.1	0.5	79.3	2.4	3.86	0.14
Swimming	14	50.4	3.7	80.3	2.2	14.2	1.8	81.1	1.9	3.84	0.09

Descriptive statistics for selected functional variables at the ventilatory threshold are given in Tables 5 and 6 for male and female athletes, respectively. The coefficient of energy cost of running (C) is also included in the tables. The functional variables at VT are practically identical among endurance oriented athletes of both sexes.

Correlations between laboratory variables and performance (race times) variables were calculated for the sample of endurance athletes. The performance times were obtained three after the laboratory tests in the athletes. Performance time was not related to pulmonary ventilation and blood lactate in a combined sample of male and female athletes. In contrast, the relationship between competition performance and several other functional variables were moderate to high: maximal oxygen uptake in ml.kg-1.min-1 (males, -0.63 to –0.81; females, -0.71 to –0.88), maximal speed of treadmill running (males, -0.60 to –0.81; females, -0.66 to –0.87), speed of running at the anaerobic threshold level (males, -0.56 to – 0.82; females, –0.71 to -0.78).

Table 6. Means and standard deviations for selected functional variables at VT and the coefficient of energy cost of running (C. with treadmill with slope of 5%) in late adolescent female athletes.

Sport	n	VO2.kg-1 (ml)		%VO2max.kg-1		v (km.h-1)		%vmax		C ($J.kg^{-1}.m^{-1}$)	
Triathlon	39	51.4	2.9	83.1	1.9	13.2	0.8	84.0	1.9	3.71	0.13
L.D. running	12	54.3	3.4	83.7	2.0	13.8	1.0	84.3	2.1	3.71	0.09
M.D. running	18	51.6	2.7	82.9	2.3	13.7	1.2	83.7	2.2	3.70	0.10
C.C. skiing	16	55.2	2.8	83.0	2.0	13.6	1.3	84.0	2.1	3.74	0.09
Biathlon	41	53.1	2.2	82.1	1.7	12.8	1.2	80.0	1.8	3.76	0.08
Cycling	11	49.7	2.9	83.1	2.4	12.6	0.9	82.0	2.5	3.82	0.08
Soccer	10	39.6	1.8	78.1	1.6	11.7	0.6	79.8	2.0	3.84	0.07
Basketball	12	38.0	1.7	77.6	1.8	11.3	0.7	79.2	1.8	3.86	0.08
Squash	14	42.6	1.6	79.7	1.6	11.9	0.9	82.1	1.9	3.82	1.00
Tennis	11	41.8	2.0	79.0	1.9	11.7	0.8	81.8	2.2	3.85	0.09
Canoeing	15	41.0	2.4	79.1	1.8	12.4	1.1	79.8	2.0	3.84	0.09
Swimming	13	46.8	3.0	80.9	1.7	12.4	1.1	81.5	2.0	3.86	0.10

4. DISCUSSION

Nowadays is currently running the debate about the basic physiological nature of majority modern sports events, particularly about the relative importance of the aerobic and anaerobic energy systems and about the degree of involvement of the lactic acid system.

The significance of the aerobic energy system may be clarified by considering the values for maximal oxygen uptakes of soccer players obtained in numerous studies over the years.

The young trained athletes typically manifest maximal oxygen values of 60-65 ml.kg-1.min-1 approximately 20-30% higher than the values of VO2max expected from general population (Astrand and Rodahl, 1986, Bunc, 1989). There are no significant differences in the maximal oxygen uptake between systematically trained children whose training is oriented toward running (fitness orientation) or playing (skill development orientation). This observation is valid even if the children train three times per week, 70 minutes per practice.

In young subjects, the combined aerobic plasticity, represented by the change in oxygen uptake in the values measured at the complete bed rest to the values measured during endurance training appears to be about 20-25% lower than oxygen uptake during endurance training (Astrand and Rodahl 1986).

In adults, the maximal oxygen uptake of 60 ml.kg-1.min-1 seems to be sufficient even at high performance levels of majority players, although there are studies, which suggests that 65 ml.kg-1.min-1 is necessary for top level adult competition (Tumilty, 1993; Reilly et al., 1990). Values of oxygen uptake around 60 ml.kg-1.min-1 are about 10 ml.kg-1.min-1 above the average for the general population of the same age, but are at least 15 ml.kg-1.min-1 below the oxygen uptake of long distance runners and cross-country skiers (Astrand and Rodahl, 1986; Bunc and Heller, 1989). Soccer players, therefore, seem to have good but not exceptional aerobic capacity.

High values of maximal oxygen uptake per unit body mass are typical for athletes with high endurance abilities (Astrand and Rodahl, 1986; Maud and Foster, 1995; Rowland, 1996). Both specific muscle mass and oxidative capacity of working muscles may be increased by specific training and thus the VO2max.kg-1 may reflect a specific predisposition for endurance exercise. Maximal oxygen uptake in trained athletes is generally higher in work situations that allow optimal use of specifically trained muscle fibres VO2max.kg-1 (Wilmore and Costill, 1994). This may underlie some of the differences in "running" VO2max.kg-1 when results of specialists in middle-distance running, cycling and swimming are compared.

The values of maximal functional variables (largely maximal oxygen uptake) are similar to those of top young Czech middle-distance runners and/or cyclists and slightly higher than elite top swimmers of the same age, which were evaluated by the same protocol. These values are lower than those found in Czech top long-distance runners of the same age. The majority of the young athletes started regular sports training in cycling and/or running. In contrast the majority of adult athletes are according to their basic single-sport orientation swimmers.

Maximal oxygen uptake has routinely been used to assess endurance running performance. In fact, successful performance in competitive distance running has been primarily attributed to $VO_{2max}.kg^{-1}$. A number of investigators have reported significant correlations between maximal oxygen uptake per unit body mass and success in distance running (Astrand and Rodahl, 1986; Dengel, 1989; O'Toole and Douglas, 1995).

The range of $VO_{2max}.kg^{-1}$ was relatively large in all groups of endurance oriented athletes, and these values are slightly lower than values in top adult athletes of the same sports event. The higher values in maximal oxygen uptake in subjects with higher performance levels suggest that a high maximal oxygen uptake is necessary to become a world-class athlete. Thus, there may only be limited possibilities to compensate for a low $VO_{2max}.kg^{-1}$. A high level of maximal oxygen uptake per se does not guarantee good performance, since technique and psychological factors may exert either positive or negative influences. In practice, this implies that both laboratory and performance must be considered simultaneously.

The literature regarding the physiological characteristics of elite young endurance athletes shows that nearly all male competitors have $VO_{2max}.kg^{-1}$ values higher than 73 and females higher than 65 $ml.kg^{-1}.min^{-1}$ (Astrand and Rodahl, 1986; Wilmore and Costill, 1994). Thus, a high maximal oxygen uptake unit body mass is often considered a prerequisite for success in endurance sports. The importance of the run segment to overall triathlon performance was recently made evident by a study which noted it to be the best predictor of overall time in a triathlon (O'Toole and Douglas, 1995).

The higher values of maximal oxygen uptake in adults than in the young athletes can be explained by the higher training state of adults, i.e. a higher degree of adaptation to exercise. The higher energy cost of running - lower running economy in young soccer players confirms this conclusion.

The other two potential factors, which could explain physiological difference between very young and adult athletes are:

- A small difference in relative VO_{2max} $.kg^{-1}$ between young and adult players (compared to a larger difference in the absolute values of oxygen uptake in young and adult trained players) may be related, in part, to a greater variation in body composition in younger subjects. As stated by Cureton *et al.* (1978), the increased body fat lowers the maximal oxygen uptake (expressed relative to body mass), because it increases body mass without contributing to oxygen use.
- The nature of training stimulus influences the capacity for improvement of maximal oxygen uptake.

The significantly lower values of LA_{max} and confirm the lower anaerobic capacity of young athletess comparing to adults. This situation is well documented in literature (e.g. Astrand and Rodahl, 1986).

Metabolic adaptation, which can be indirectly characterized as the ability to utilize effective the functional capacity of the organism during a prolonged period, can be estimated as the percentage of maximal functional variables (mainly maximal oxygen uptake) at VT (Bunc *et al.*, 1987). In untrained subjects, % VO_{2max}.kg^{-1} is in the range of 50%-70% of maximal oxygen uptake; in trained subjects, values are in the range of 80%-90% of VO2max (Bunc *et al.*, 1987; Wilmore and Costill, 1994)

The higher the level of adaptation to physical activity, the higher the values of %VO_{2max} at the VT level. The untrained children of the same age as our young players, which were evaluated in our laboratory by the same protocol had values of %VO_{2max} in the range of 60-70%. The young long distance runners had the same values ranging from 80% to 86%.

Balsom (1988) found no significant correlation between performance decrement and anaerobic threshold expressed as percentage of maximal oxygen uptake. His moderately trained college players had a threshold value of 70.5% of maximal oxygen uptake, which is somewhat lower than the values reported by several other investigators. The adult players in our older study (Bunc *et al.*, 1987) had a % VO_{2max} value of 80.5%. Rhodes *et al.* (1986) found the same value of %VO_{2max} in the Canadian Olympic Team and considered it to be „remarkably high for anaerobically trained athletes".

The dilemma for the coach and player is to determine how to improve fitness through an organized fitness programme without sacrificing player's game performance and without neglecting skill development, which gave game its unique character. This is a special concern for very young players, who must firstly try to improve their basic motor abilities. It is likely that an increase in fitness level will be more useful if there is an improvement in the player's skill and the game sense.

As in other sports, where skills play an important role, the functional data are not the sole predictor of game success, but they play a decisive role in the selection of young players for competitive soccer teams and for a long term training process.

The total energy cost of training loads imposed on the group of young athletes during the year was more or less independent of the quantitative and qualitative structure of training. Almost constant energy demands of the training programme resulted in practically constant values of maximal functional variables associated with maximal oxygen uptake per kg body mass during one year of training. Any change in the functional variables can only result from the basic alterations in the quality and, in particular, the quantity of training programs for top level soccer players. These changes are most unlikely to occur during a single year. This suggests that the maximal oxygen uptake related to kg body mass can be changed in trained athletes only with a great difficulty, consequently it has a little practical use for evaluating the effect of the training stimulus on the course of adaptation to this level of exercise (Brooks, 1985; Bunc *et al.*, 1987; Costill, 1976).

The changes in absolute values of maximal oxygen uptake in children are mainly connected with changes in the body mass (Astrand and Rodahl, 1986). On the other hand, the changes in energy cost of moving, generally in adaptation to exercise, are significantly influenced by the duration of training.

The coefficient C can be used for the evaluation of the adaptation to the specific movements of a sport (Bunc and Heller, 1989). The higher the level of adaptation to a given type of exercise, the lower the amount of energy necessary to transfer 1 kg of body mass along a distance 1 m. If it is assumed that adaptation to running is highest in runners, then this is reflected in the lowest values of C in runners of both sexes against to values in players or non-runners (Bunc and Heller, 1989). The lowest values of C are perhaps the result of running training because these athletes were forced to exercise at very high speed, specifically middle distance runners of both sexes.

The data and results from other groups of endurance oriented athletes suggest that there may be some critical level of maximal functional variables (mainly maximal oxygen uptake) below which an athlete will not be successful. However, above this theoretical critical level, other factors play a more important role in performance.

It should be cautioned that physiological capacities are not the sole predictors of racing success. Nevertheless, they provide significant insights into the basis of endurance performance.

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Part 4:

INJURIES TO YOUNG ATHLETES

INJURIES IN YOUTH SPORTS

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1. INTRODUCTION

Injury in sport is commonly discussed in the medical and youth sport communities, but there is generally more public health concern for childhood injuries and injury-related deaths associated with automobiles (occupant and pedestrian), bicycles (especially traffic-related), firearms, drowning, fire, poison, and falls (Behrman, 2000). Nevertheless, risk of injury is inherent in sports and many other activities of childhood and adolescence. It is not clear, however, whether injuries in organized youth sports occur at a higher rate than in other activities of children and adolescents. This chapter provides an overview of concepts, issues and sources of information related to injuries in youth sports.

2. WHAT IS AN INJURY?

There are no standardized definitions of an injury in sport, including youth sport. For example, an injury has been defined as an incident that requires the participant to miss all or part of a practice or game (DeLee and Farney, 1992), and as a disabling event evaluated by a trainer or physician at a practice and/or game that requires cessation of play (Roberts *et al.*, 1999). An American College of Sports Medicine Roundtable on Injuries in Youth Sports (Kohl *et al.*, 1996) suggests that a sports injury "...is an adverse event which occurs during an organized training session, practice, and/or event, and which restricts participation in that sport for at least 24 hours." The National Athletic Trainer's Association (NATA) injury surveillance of high school sports used an expanded concept of a "reportable injury," which was defined by several criteria:

> "Any injury that causes cessation of participation in the current game or practice and prevent's the player's return to that session.
>
> "Any injury that causes cessation of a player's customary participation on the day following the day of onset.
>
> "Any fracture that occurs, even though the athlete does not miss any regularly scheduled session.

"Any dental injury, including fillings, luxations, and fractures.

"Any mild brain injury that requires cessation of a player's participation for observation before returning, either in the current session or the next session" (Powell and Barber-Foss, 1999, p. 278).

The preceding examples indicate the operational nature of the definition of an injury used in surveys of youth sports. Nevertheless, a common thread in all definitions is that an injury involves removal from participation in a sport.

2.1. Acute and Overuse Injuries

Injuries can be classified in several ways. Many studies focus on injury type (abrasion, sprain, fracture, mild traumatic brain injury, etc.), anatomical location of injuries (head, spine/trunk, lower extremity, upper extremity), and perceived injury severity (mild, moderate, severe). Injuries are also defined as acute, overuse and chronic.

Acute injuries refer to a major traumatic event (macrotrauma), such as a fracture, sprain, contusion, laceration, concussion, and others. Acute injuries are generally represented in the injury records of emergency rooms, insurance records, sports medicine clinics, and so on.

Overuse injuries are a consequence of repetitive microtrauma below the threshold associated with acute injury. They are associated with excessive repetitions of a specific sport activity as in baseball pitching, swimming, and distance running. Overuse injuries commonly occur at joint surfaces; thus sport specific labels are often used, e.g., Little League and tennis elbow, and swimmer's shoulder. Overuse is also implicated in stress fractures, especially when the mineral integrity of a bone is compromised as in young female distance runners and gymnasts. Overtraining is an important issue in overuse injuries associated with sport.

The term chronic refers to an injury that persists over a long period of time. A chronic injury may result from overuse and/or acute injuries.

3. RISK FACTORS FOR INJURY

Many discussions of injuries in youth sports focus on characteristics and/or conditions that might place a youngster at risk for an injury (Micheli, 1985; Caine and Lindner, 1990). These are labeled as "risk factors." Potential risk factors are commonly described in the context of the young athletes, i.e., player-related or internal risk factors, and in the context of the sport environment - external risk factors. Needless to say, interactions between the athlete and the sport environment are central to injuries.

3.1. Internal Risk Factors

Potential risk factors related to the young athlete include the following:

- Physique, the child may not have the body build suitable for a specific sport;
- Problems in structural alignment;
- Lack of flexibility;
- Lack of muscular strength or strength imbalance;
- Marginal and/or poor skill development;
- Behavioral factors, including risk taking and inability to cope with stress;
- Injury history, specifically inadequate rehabilitation from prior injury;
- The adolescent growth spurt: individual differences in timing and tempo, strength imbalance, reduction in flexibility, adolescent awkwardness;
- Maturity-associated variation, maturity mismatches in size and strength, late maturation.

The contribution of internal risk factors of young athletes to injuries in sports is neither known with certainty nor specified. There is a need for more specific information on the unique aspects of these factors, and perhaps others, that may place a young athlete at risk for an injury. For example, what is it about the growth spurt that places the adolescent sport participant at risk? The association between increased prevalence of injuries and the adolescent growth spurt has been long recognized (e.g., Dameron and Reibel, 1969). The term association needs to be emphasized. There are no prospective or longitudinal data that relate injuries to parameters of the adolescent growth spurt. Youth who present to a clinic with an injury are ordinarily seen only on this occasion and it is virtually impossible to estimate where a child is in his or her growth spurt based on one observation.

Longitudinal data on bone mineral accrual during the adolescent growth spurt indicate that the peak velocity of growth in bone mineral content occurs after peak velocity of growth in height by more than one year, on average (Iuliano-Burns *et al.*, 2001). The lag in bone mineral accrual relative to linear growth may suggest a period of skeletal "fragility" which might contribute to the increased occurrence of injuries (sport and non-sport) during the adolescent spurt.

Other changes during the adolescent growth spurt also need consideration. Loss of flexibility, for example, is indicated as a risk factor. Flexibility, however, is joint specific and is a highly individual characteristic. Girls, on average, are more flexible than boys, and the range of motion of some joints increases during puberty in contrast to the general suggestion that flexibility decreases. Loss of flexibility in athletes during adolescence may be sport specific, e.g., shoulder and back flexibility in tennis players or loss of quadriceps flexibility in soccer players (Kibler and Chandler, 1993). Although flexibility and strength (static and explosive) are not related, it has been suggested that an imbalance between strength and flexibility may lead to abnormal movement mechanics, which in turn may be a risk factor for injury.

Peak gains in muscular strength and power occur, on average, after peak gains in height and closer in time to peak gains in body weight. Does this contribute to the strength imbalance described in some adolecent athletes? The role of "adolescent awkwardness," which is often attributed to rapid growth (see Malina *et al.*, 2003), also needs consideration in the context of injuries.

Maturity-associated variation in body size, strength, power and other performance characteristics are magnified during the transition into adolescence (9-13 years) and in adolescence per se (14-18 years). Hence, an important question is the following: What is the contribution of maturity mismatches in size, strength and power to injuries? Unfortunately, the maturity status of youth sport participants has not be systematically related to injury.

Finally, given the association among age, experience, growth, and maturation, is age of participants a specific risk factor? How do age, experience, growth and maturation interact in the context of sport injuries? Is lack of skill a risk factor? Are the more skilled more able to avoid the risk of injury, or are the less skilled less likely to avoid the risk of injury?

3.2. External Risk Factors

Potential risk factors associated with the sport environment include the following:

- Inadequate rehabilitation from prior injury – loss of conditioning, flexibility and strength;
- Training errors - improper technique, lack of adequate instruction, use of inappropriate drills, lack of conditioning;
- Playing conditions - structural hazards: goal posts, fences, sprinklers; surfaces: uneven, wet, foreign materials; environment: lighting, heat/cold, humidity, lightning; proximity to spectators;
- Equipment - availability, improper and ill fitting, "hand-downs;" equipment required to play (goals, bats); equipment required for protection (pads, helmets); equipment that is optional for protection (mouth guards); maintenance of equipment;

- Age groups – size, maturity and experience mismatches in broad age groups;
- Coach behaviors – inappropriate drills and techniques, poor instruction, forced participation of an athlete after injury or incomplete rehabilitation;
- Parent behaviors - unrealistic expectations, pushing a child too fast, having a child "play-up" in an older age group;
- Sport organizations (administrators, coaches, and officials) - increased tolerance for aggression and body contact in some sports (ice hockey, soccer, football, basketball).

The unique feature about risk factors related to the sport environment is that they can be controlled and perhaps modified to reduce the risk of injury. External risk factors in youth sports are largely under the control of coaches, parents and sport administrators, i.e., adults.

There have been several successful efforts at reducing injuries in sport by introducing changes in the sport environment. These include the intrroduction of breakaway bases in youth baseball and softball, elimination of the trampoline from high school gymnastics competition, and elimination of "spearing" or spear tackling in football (Hergenroeder, 1998). Nevertheless, introduction of changes designed to prevent injuries in a sport is a difficult process. The difficulties and related complexities are especially evident in efforts to introduce softer and safer baseballs, Reduced Injury Factor (RIF) baseballs (Hergenroeder, 1998).

Although factors in the sport environment are potentially manageable from the perspective of injury prevention, it is somewhat myopic to suggest that injuries would not have occurred had circumstances been ideal. And, the assumption that many injuries among youth sport participants are preventable must be substantiated in terms of specific risk factors and sport contexts, and effective interventions. Hergenroeder (1998) presents an excellent discussion of issues related to the prevention of injuries in youth sports.

One intervention that is often mentioned in the prevention of youth sport injuries is the education of coaches. However, sound data to the effectiveness of coaches in the prevention of injuries are lacking. An early study of high school football injuries (Blyth and Mueller, 1974) suggests an inverse assocation between age of the coach and injury rate of their teams, i.e., coaches with more experience (20+ years) have a lower injury rate than coaches with less experience (<5 years). This, of course, is the high school level, and given the stresses associated with coaching at his level, the number of coaches with 20+ years experience is probably very small. At younger age levels, coaches have much less experience. In many youth sport programs at local levels, the majority of coaches are volunteers, very often with minimal experiences in the sport and little formal training in teaching children in the context of the sport. The ranks of volunteer coaches also experience major turnovers on an annual basis. In other words, adults who work with youth sport programs are a transient population.

Coaches can be influential in the prevention and/or occurrence of injuries. Many risk factors for injury are to some extent under the control of coaches (see above), and coach education programs often place emphasis on injury prevention. Does coach education play a significant role in the prevention of injuries? Data are presently unavailable to evaluate the role of coach behaviors and/or coach education programs in the prevention of injuries.

Although the education of coaches may be important to the safety of youth sport participants, several important questions need to be addressed. What is the role of the youth sports coach in the prevention of injuries, and in providing first aid and/or health care for injuries? How can coach education programs be improved to enhance injury prevention? Coaches should be educated about awareness of safety issues in the respective sport and in the recognition of and response to injuries. Coaches should also be prepared to provide first aid and should have an emergency medical reponse plan in place. Given concern for litigation associated with the on-field care of injured athletes, coaches may also be expected to show competence in cardiopulmonary resuscitation and advanced first aid (see American Red Cross, 1997). Coaches need to be aware of the legal implications of injuries sustained by youth who are under their supervision in sport. For example, what are the potential legal consequences for failing to act in case of an injury, or for selecting an improper course of action, or for selecting a proper course of action but failing to carry it out in the correct manner?

Parents can assist coaches in injury prevention by providing information to coaches and others involved with the administration of youth sport programs on the medical history and specifically the injury history of the child or adolescent athlete. They should likewise insure that their child is completely recovered or rehabilitated from an injury before permitting him/her to return to the sport. Since previous injury is a risk factor for future injury, it is important that coaches in cooperation with parents ensure complete rehabilitation, modify training demands to accommodate the rehabilitation process, and of course, be able to recognize symptoms related to the injury.

4. INJURY RATES

The term rate refers to a ratio between two things. In sport injury epidemiology, several rates have been defined. As an example, several specific incidence rates were used in the National Athletic Trainers Association survey of injuries among high school athletes (Powell and Barber-Foss, 1999):

- case rate/100 players = number of injuries/total number of players
- player rate/100 players = number of players sustaining at least 1 injury/total number of players
- case rate/100 athlete exposures = number of injuries/number of athlete exposures.

Specific case rate per athlete exposure can be calculated separately for practices and games, and these can then be compared in the incidence density ratio: game injury rate/practice injury rate

Estimates of injury rates among youth sports participants are variable and limited, especially limited for local, agency sponsored, club and recreational sports. On the other hand, injury data are more systematically available for interscholastic sports, intercollegiate and professional sports.

Available studies of young participants are often limited to clinical observations and do not include suitable athlete exposure data, i.e., opportunities for injury, for practices and competitions. Focus is on the injured and data for athletes who are not injured are not reported or retained in order to derive rate estimates. Exposure data, i.e., all youngsters involved in a practice or a game, provide the denominator that is necessary for estimating rates.

5. SOURCES OF DATA ON INJURY

Sources of data on injuries in youth sport participants are diverse. They include accident reports, clinical records (hospitals, emergency rooms, sport injury clinics), insurance records, interviews, retrospective questionnaires, and various combinations of information. Such studies provide estimates of age-, sex- and sport-associated variation in the occurrence and type of injuries, but the rate of injuries is not known and the specific context of injuries is not ordinarily considered. The definition of an injury and reporting protocol are not standardized among studies. Some injuries are defined as a sport injury if the youngster was using a piece of sports equipment at home and not involved in an organized form of the sport. The NATA high school injury surveillance project utilized certified athletic trainers who worked directly with school athletic programs and a standardized reporting protocol (Powell and Barber-Foss, 1999).

Data from clinical series, case reports, and insurance company statistics are limited because only individuals who are presented to medical and/or insurance personnel are included. Individuals who are injured, but who are not presented to medical and/or insurance personnel, are not represented in the statistical base. Thus, they probably underestimate the true incidence of injuries in sport, since it is likely that many minor injuries are unreported or self treated. Further, only more severe and catastrophic cases are often included in clinical series and case reports.

The National Electronic Injury Surveillance System (NEISS) is a program utilized in the United States. It is limited to injuries that require medical care in a hospital emergency room (Mueller and Blyth, 1982). The NEISS data provide national projections, but the data are limited in their utility in identifying the sport-specific context of the injuries and in establishing injury rates because information on the number of exposures is lacking.

Systematic procedures for collecting information on injuries associated with participation in sport are not in place, and there is a recognized need for such information from the perspective of public health. Intercollegiate programs in the United States have systematic procedures in place. There is also a need to systematically collect information on numbers of participants and exposures, or perhaps duration of participation and exposures, in practices and competitions in youth sports programs at the local level. This is important from two perspectives, first, to obtain estimates of the prevalence and incidence of injuries in youth sports, and second, with this information in place, to develop preventive measures with the goal of preventing andreducing the incidence of injury in youth sport.

6. INJURY SURVEYS

It is beyond the scope of this discussion to summarize results of injury surveys of youth involved in sport. Surveys generally fall into three categories: general, multiple sport, and sport-specific. Several examples of each will be subsequently indicated.

6.1. General Surveys

Two general surveys are cited as examples. The Child Health Supplement to the 1988 National Health Interview Survey conducted by the United States National Center for Health Statistics provides an estimate of the incidence of injuries associated with sport and recreational activities (Bijur *et al.*, 1995). The survey considers non-fatal accidents, injuries or poisoning in children and adolescents 5-17 years of age that received medical attention in 1988. The data were reported by an adult in the households surveyed, most often the mother of the youngster. Data from the National Health Interview Survey do not include information which would permit estimates for organized sports, for specific sports, and for the sport-specific context of the injuries.

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an emergency room-based injury surveillance program in ten pediatric hospitals, which specifically identifies sport injuries among other types of injuries in children and youth 5-17 years (Ellison and Mackenzie, 1993). In contrast to the United States interview data, the CHIRPP survey provides sport specific information.

Such surveys provide general trends for sport-related injuries in children and adolescents. The number of injuries increases with age and reaches a peak during adolescence; peak age of occurrence is earlier in girls than in boys by about two years. Hence, the adolescent growth spurt and/or associated behaviors may be implicated in sport-related injuries. Injuries occur more often in boys than in girls, but the studies do not control for sex differences in numbers of participants, i.e., more boys than girls generally participate. Fractures, sprains/strains, and contusions are the most commonly reported and/or treated injuries. The surveys focus almost exclusively on acute injuries. Overuse injuries are not ordinarily considered.

6.2. Surveys of Multiple Sports

Three types of surveys of young athletes involved in several sports are briefly described. The reader is referred to the original reports for specific injury data.

The Training of Young Athletes (TOYA) study in the United Kingdom was a mixed-longitudinal study of elite young athletes, 8-16 years of age, in four sports – soccer (boys only), gymnastics, swimming and tennis, from 1987 through 1990. An injury was defined as one that occurred as a result of participation in sport and that had one or both consequences: reduction in sport activity or need for treatment. The context (practice, competition, non-sport), and overuse and acute injuries were considered (Sports Council, 1992; Baxter-Jones *et al.*, 1993).

National registry data in Finland provide the basis for a survey of acute sport injuries (Kujala *et al.*, 1995). Participants in competitive soccer, ice hockey, volleyball, basketball, judo or karate were required to obtain a license from the respective sport organizations, and for four of the sports, the license was related to an insurance policy, which covered acute sport injuries (insurance was not compulsory in two sports but the majority of participants had coverage). The data are based on sport participants linked to insurance records. Of relevance to the present discussion,data are reported for participants <15 years and 15-19 years.

The National Athletic Trainers Association (NATA) surveillance of high school injuries during the 1995-1 academic years permits comparisons of five sports in males and five sports in females (Powell and Barber-Foss, 1999, 2000). The NATA project also permits comparison of similar (baseball/softball) or the same (basketball, soccer) sports in males and females. A standardized definition of injury was used (see above), and all injuries were reported by certified athletic trainers.

6.3. Surveys of Specific Sports - European Football (Soccer) as an Example

It is beyond the scope of this brief review of injury in youth sports to cover the many sports available for children and adolescents. Examples from one sport will suffice. Participation in youth soccer programs is world wide and has increased dramatically in the United States over the past two decades. From the perspective of injury, soccer in many countries presents three interesting features. First, the sport has a high frequency of weekend or 4-5 day tournaments, which require participation in several games over a rather concentrated period of time. Second, there is increased popularity of soccer programs for girls so that concern for potential sex differences in the incidence of injuries has been expressed. Third, special summer camp programs, which include intense exposure to training and competition over a limited time, usually about one week, are increasing in popularity.

Estimated injury rates in youth soccer derived from two 5 day soccer tournaments in Norway and Denmark, about 15 years apart, are subsequently summarized. The first is based on international tournaments in 1975 and 1977 which included 1,549 teams, 25,000 players 11-18 years of age, and 2,987 games (Nilsson and Roaas, 1978, p. 358). During the course of the tournament, 56% of all consultations with the medical staff were for injuries during games, 32% were for other injuries and accidents, and 12% were for illness. Overall, the estimated incidence of injury was about twice as large in girls as in boys, 44/1000 versus 23/1000 hours of play. When minor medical concerns were eliminated (skin abrasions and blisters, 39% of all medical consulations), the sex difference in the estimated incidence of injuries was greater, 32/1000 versus 14/1000 hours of play. The authors attributed the sex difference in injuries to limited experience, training and skill in girls. Another factor may be age grouping. Males were categorized into four 2-year age groups, 11-12,13-14, etc., whereas females were placed into two broader age groups, 11-14 and 15-18 years. There thus may have been a greater likelihood of size mismatches, particularly among younger female participants. Age-specific estimates of injuries among boys varied between 12 and 15/1000 hours of play among the four age groups; sex-specific estimates by age group for girls were not reported. The frequency of injuries was greater in the final rounds of the tournament, where winning teams played up to 3 games per day and fatigue could have been a factor, and the sex difference was 2:1 in favor of females. The three most commonly reported injuries (excluding abrasions and blisters) were contusions, sprains/strains, and fractures. About two-thirds of the injuries were to the lower extremities (Nilsson and Roaas, 1978).

In the more recent soccer tournament over five days and involving 12,907 boys and girls 10-19 years of age and 785 teams in 1991 (Andreasen *et al*, 1992), injuries were classified non-sport related and illnesses, minor injuries during a practice or game, and severe injury during a game (not permitted to play the next match or withing 24 hours). There was no sex difference in the relative frequency of injuries in each of the three categories. There also was no sex difference in the incidence of severe injuries, 3.6 and 4.4/1000 hours of play in males and females, respectively. The incidence of severe injuries increased with age into adolescence, reaching a peak at 14-16 years in males and at 12-14 and 14-16 years in females. The authors attributed the peaks in severe injuries during the adolescent years to pubertal changes in physical characteristics, although specific details of the growth spurt and sexual maturation that may relate to the risk of injury in soccer were not considered. Consistent with the earlier tournament study, contusions, sprains/strains, and fractures were the three most common severe injuries, and 77% of the injuries occurred while the injured youth was in contact with another player. Severe injuries occurred more often during the second half of games in both sexes, but the incidence of severe injuries did not differ between games played in qualifying and final rounds of the tournament.

In the context of a special one week summer camp for soccer, injuries were limited to problems that resulted in missing full participation in one or more camp sessions (Backous *et al.*, 1988). The relative number of injuries tended to increase with age from 6 to 17 years, with the greatest percentage occurring in youth □15 years of age. Overall, the estimated rates of injuries were 7.3 and 10.6/1000 hours for boys and girls, respectively. The most common injuries were contusions and strains/sprains (>80% of reported injuries), and about one-half of the injuries occurred as a result of contact with other players.

A factor that may influence the occurrence of injuries in soccer (and in other sports as well) is level of competition. Among Dutch male soccer players 13-18 years of age, the rate of injuries during the course of a season was greater in teams at a higher level of play (elite/select) compared to those at a lower level of play. Interestingly, about one-half of the injuries present in the soccer players before the start of the survey (48%) and about one-third of the injuries incurred during the survey (35%) were classified as overuse (Inklaar *et al.*, 1996).

Potential consequences of "heading" the ball in soccer is receiving more attention. In a current review, the American Academy Pediatrics (2000, p. 660) emphasized the need for further research on the safety of heading in youth soccer:

> "Currently, there seems to be insufficient published data to support a recommendation that young soccer players completely refrain from heading the ball. However, adults who supervise participants in youth soccer should minimize the use of the technique of heading the ball until the potential for permanent cognitive impairment is further delineated."

The American Academy of Pediatrics (2000) also draws attention to the occurrence of fatalities in youth soccer. Though rare, soccer-related fatalities were almost always the result of traumatic contact with goalposts or of falling goalposts, most often in younger players. This has implications for safety procedures relating to securing soccer goalposts during play as well as when they are not in use.

7. SUDDEN DEATH IN YOUNG ATHLETES

Among inherent risks in sport is the risk of death. Deaths at young ages, specifically in the context of sport, are rare. Nevertheless, when death occurs in a young athlete, media attention is often considerable. It is important, therefore, to be aware of the remote possibility of sudden death in sport and of the need for shared responsibility for sports safety among athletes, parents, coaches, and sport organizations.

Several recent reports have described individual cases of sudden death in sport that have been accumulated over relatively long periods. Maron *et al.* (1995) presented the clinical profile of 25 children and adolescents 3-19 years of age who died from cardiac arrest while participating in organized or recreational sports from 1977-1995. The 25 cases, 24 males and one female, collapsed with cardiac arrest after receiving an unexpected blow to the chest. Death ensued from "commotio cordis" or "cardiac concussion." The specific cause of the deaths is not known with certainty, but may be related to the thinness of the chest wall in children and adolescents, which yields to the force of the projectile or blow, thus facilitating the transmission of the force to the heart. The sex difference in prevalence is probably related to the greater number of young males involved in sport, although other unidentified factors may be involved.

Two other reports have considered cases of sudden death in adolescents and young adults associated with vigorous exercise (Van Camp *et al.*, 1995; Maron *et al.*, 1996). The former described 160 cases of non-traumatic death in high school and college athletes, 13 to 23 years of age, in a variety of sports between 1983 and 1993 (Van Camp *et al.*, 1995). The ratio of males to females was about 10 to 1, 146 males (16.9± years) to 14 females (16.2± years). The latter described the clinical profile of 134 athletes, 12 to 40 years of age, who suddenly died of cardiovascular-related complications in sport between 1985 and 1995 (Maron *et al.*, 1996). Ninety percent of the athletes died during or immediately after a training session or an athletic competition. The ratio of males to females was again about 10 to 1, 120 males to 14 females. The median age at death was 17 years, i.e., one-half of the cases were between 12 and 17 years of age.

In both studies, the major contributor to sudden death from cardiovascular causes during sport was hypertrophic cardiomyopathy, a pathological thickening of the walls of the left ventricle that obstructs blood flow from the left ventricle to the aorta. The majority of cases had no symptoms. The second most common cardiovascular cause of death in both studies was congenital anomalies of the coronary arteries. A variety of rare cardiovascular conditions as well as several apparently "normal hearts" were represented in the remainder of cases of sudden death in young athletes. A relatively large number of non-cardiovascular causes (30 of 136) of sudden death were identified in the high school and college athletes. These included 13 from hyperthermia, 3 from electrocution due to lightening, and 4 associated with asthma. All of these are preventable conditions.

What are the implications of these studies of sudden death for youth sports? Parents, coaches, and youth sports administrators should be aware of inherent risks in sports, including the rare possibility of death. A meeting sponsored by the National Athletic Trainer's Association, Research and Education Foundation (October 1996) highlighted the awareness of the problem of sudden death in athletes, particularly nontraumatic deaths. Several preventive procedures were discussed: (1) requiring a proper preparticipation physical examination, but recognizing that such an examination does not guarantee that cardiovascular problems will necessarily be identified; (2) taking on field preventive measures, especially in the context of non-cardiovascular causes of sudden death, e.g., hydration of athletes, scheduling practices at the right time of the day so as to avoid the hottest times of the day, awareness of lightening and thunderstorms in the area; (3) monitoring athletes on the field, i.e., be aware of "red flags" or who is having trouble; and (4) having an emergency plan in place for practices and games, e.g., cardiopulmonary rescusitation training, access to a telephone, etc.

8. SUMMARY

Risk of injury is inherent in sport as well as in many other activities of childhood and adolescence. It is not known with certainty, however, whether injuries in organized youth sports occur at a higher rate than in other activities of children and adolescents. Nevertheless, if prevention of injuries in youth sports is a major objective, they need to be understood better.

Presently available data for injuries in youth sports are largely focused on rates for specific sports. Data on the context (practice versus game, specific situations in practices or games) and mechanisms (collision, indirect versus direct force, shear forces) of injuries in specific sports are limited. There is little information about injuries at the player level, i.e., characteristics of the individual who is injured or who might be susceptible to injury.

There is a need for systematic collection of comprehensive data on injuries in youth sports, especially at local levels of competition. The vast majority of children have their first sport experiences and probably their first injury experiences at these levels. Data for older ages and the high school level are more extensive, but generalization from older to younger ages may not be relevant and/or need to be made with caution.

Although injury in sport is commonly discussed in the medical and youth sport communities, it is not known with certainty whether there has been a real increase in the number of injuries. Is the "increase" in youth sports injuries real or perceived? Much of the data for youth sports at the local level generally lack suitable exposure data to estimate rates. By and large, however, youth sports are safe activities and most injuries are minor. Severe injuries do occur, and it is essential that adults who work with youth sports (coaches, league administrators, parents) be prepared to provide competent, timely and effective care those who are injured.

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RISK OF INJURY IN YOUTH SPORT: THE ROLE OF PSYCHOLOGICAL FACTORS

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Questions to consider?

- What are the risks of injury in youth sports?
- How do psychological factors affect the risk of injury among youth sport participants?
- How do other factors interact with psychological factors to influence the injury process?

1. INTRODUCTION

John is a 13 year-old youth soccer player who currently has a mild ankle sprain. This is his third injury during the past month. Previously, he incurred a contusion during a tackle of an opponent, and before that, he had a mild concussion after a collision with an opposing goalkeeper. John's coaches and parents are concerned about John's propensity to be injured. Why does John continue to be injured? Do his behaviors and thoughts influence the likelihood of him being injured? Are John's stress and anxiety levels affecting the likelihood that he is injured? Or is it that there are certain youth sport participants who, like John, have a certain set of personality characteristics that make them more likely than others to be injured?

Many of us would agree, anecdotally, that this last statement has some merit, as we all know athletes like John who seem to be injured more often than other athletes. However, the notion of an 'injury prone' (Lysens *et al.*, 1989; Taerk, 1977) athlete or personality has not been supported empirically (see *Personality* section). Injury involves a multidimensional process influenced by a myriad of factors; among them, life stress, competitive anxiety, social support and other psychological factors. During the last decade, researchers and practitioners alike have focused considerable efforts toward understanding the psychological factors affecting the injury process in sport (Williams and Andersen, 1998). Most of these studies have focused on adult sport participants, at the exclusion of youth sport participants. As a result, much of what we suppose regarding the role of psychological factors in injury among youth is generalized from research on adult sport participants. Hence, the purpose of this chapter is to review the extant literature and discuss the psychological factors that are related to injury in sport. Information specific to youth sports and factors that interact with psychological factors in regard to injury will be explored. Additionally, this chapter will offer the reader a multidisciplinary framework from which to consider injury in youth sport. A brief overview of the inherent risks of injury in youth sport is presented first.

2. RISK OF INJURY IN YOUTH SPORT

Most studies of injury in youth sport have focused on adolescents (i.e., approximately 13-18 years), as they are a more readily accessible group for study. The limited information on youth (i.e., <13 years) sport participants is due to a variety of reasons including the informal nature of sports at the youth level, difficulty in gaining access to youth athletes, and unreliability of self-report data collection methods at this level. Consequently, much of the available information regarding the risk of sport injury for adolescents may have limited generalizability to youth sport participants under the age of 13 years. None the less, this information helps to frame the discussion of the role of psychological factors in sport injury risk for both adolescents and youth.

It is estimated that between 3 and 5 million injuries occur annually among 5- to 17-year-old sport participants in the United States (Bijur *et al.*, 1995). These numbers translate to an annual injury risk rate of approximately 6-7 injuries/100 sport participants (Bijur *et al.*, 1995). Injury risk rates vary by age, sex, and sport type. Regardless of sex, older (i.e., late adolescent) athletes, who typically are competing at more advanced levels, are more likely to be injured than younger athletes (Bijur *et al.*, 1995). Research also indicates that males tend to have more injuries than females (Whieldon and Cerny, 1990). However, this finding belies the fact that females may have a greater risk of injury than males competing in the same or similar sports. Powell and Barber-Foss (2000) reported that females had considerably higher respective rates of injury than males in the following sports: soccer, basketball, and softball/baseball. Moreover, females were more susceptible to certain injuries (e.g., ACL tears) than males (Powell and Barber-Foss, 2000). Sport injury statistics regarding the influence of sex are often misleading, as sport type interacts with sex to affect these findings. Specifically, females lack significant participation in or have no equivalent counterpart to sports such as American football, rugby, and hockey, all of which have relatively high rates of injury. Hence, the across sport sex comparisons of injury rates suggest that males have higher injury rates than females, when in fact, this is not always the case.

Certain sports carry higher overall risks of injury for youth than other sports. In general, it is recognized that collision sports such as American football, rugby, and hockey have the highest rates of severe injuries (e.g., fractures, dislocations, spinal and head injuries) due to the purposeful contact that occurs on a regular basis between players in these sports (Nicholl *et al.*, 1995; Powell and Barber-Foss, 1999). Contact sports such as soccer (Nicholl *et al.*, 1995), basketball (Powell and Barber-Foss, 1999), and field hockey (Nicholl *et al.*, 1995) also have a significant risk of injury associated with them. However, of greater importance to coaches, parents and athletes is that each sport is characterized by a specific type or location of injuries. For instance, one could logically infer that youth soccer players have a high risk of knee injuries due to the lateral lower body movements inherent to the sport, where as distance runners are more likely than soccer players to incur shin splints as a result of the repetitive motions of linear running on a hard surface. Research suggests that ACL knee injuries, which often are the result of injury mechanisms involving lateral movements, are higher in soccer than in other sports (Powell and Barber-Foss, 2000). Participants in collision sports such as American football are at greatest risk for traumatic head injuries (Powell and Barber-Foss, 1999). In contrast, soccer players may be at risk for increased neurocognitive symptoms and impairment, and head injuries from heading (Kontos, 2002; Matser *et al.*, 1999). However, given the current body of empirical knowledge, the relationship between heading and subsequent long-term development of symptoms and injury is at best speculative. Regardless, these examples illustrate the importance of sport type in determining specific injury risk in youth sports.

Although sport type, sex, and age play an important role in determining injury risk in specific sports, they are factors that are essentially out of the control of coaches, parents and athletes. Psychological factors, on the other hand, not only play a significant role in affecting injury outcomes across different sports; they are also amenable to change and prevention strategies.

3. PSYCHOLOGICAL FACTORS AND INJURY IN SPORT

The relationship between psychological factors and injury in sport has been examined empirically since the 1970s (e.g., Bramwell *et al.*, 1975). In spite of the nearly three decades of research on psychological factors and injury in sport, researchers have uncovered few consistent relationships. The inconsistent findings in the literature are a product of poor methodologies (e.g., use of retrospective reporting of data), the lack of consensus on operational definitions of injuries and psychological factors, and incomplete or inappropriate statistical analyses (i.e., lack of moderator analyses). Despite these issues, consistent empirical support revolving around life stress and related factors such as social support/coping, emotional states and competitive anxiety has emerged (Junge, 2000; Williams and Andersen, 1998).

The most prominent theoretical framework for understanding the relationship between psychological factors and injury in sport is the stress model of sport injury (see Figure 1: Williams and Andersen, 1998). The stress model proposes that sport injuries are a result of athletes' stress responses to specific athletic situations. The stress response consists of an interaction between an athlete's cognitive appraisal of the situation and their physiological/attentional changes. For example, a rugby player who cognitively appraises an opponent as violent and malicious may respond with muscle tension (i.e., physiological) and attentional focus narrowing, which may then set the stage for subsequent injury. This stress response is moderated by three interactive factors: (a) personality, (b) history of stressors, and (c) coping resources. The model indicates that interventions, such as cognitive restructuring, imagery or relaxation training also moderate the stress response. An athlete's stress response ultimately determines injury outcome.

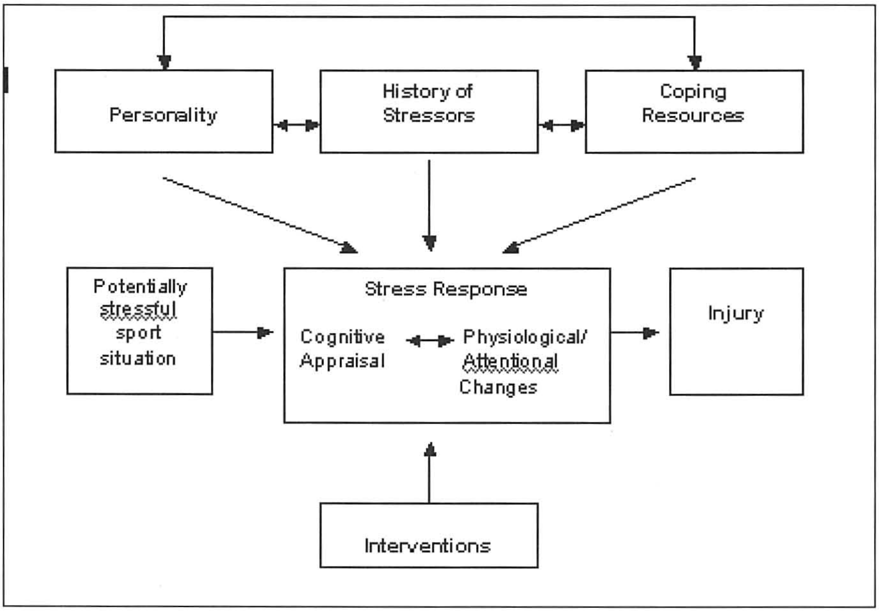

Figure 1. The stress model of injury in youth sport

Researchers have found support for a variety of factors in the stress model that influence the likelihood of injury among sport participants such as life stress (see Kontos and Foret, 2001 for a meta-analytic review of the life-stress and injury relationship), sensation seeking (e.g., Smith *et al.*, 1992), and social support (e.g., Andersen and Williams, 1997). A review of the findings related to these and other history of stressors, coping resources, and personality factors is presented below. Much of the information reviewed in the following sections is based on studies of adult sport participants. Wherever possible, studies on youth sport participants and additional information relating to youth are provided.

4. HISTORY OF STRESSORS

The most consistently supported findings in the psychology of injury literature pertain to the relationship between psychosocial stress and injury. Stress has been delineated into life stress events (e.g., death, loss of a friend) and daily hassles (e.g., traffic, communication with teammates). For the purpose of this discussion, the term life stress will refer to both types of stressors. Life stress, in particular, stress related to sport, is proposed to affect injury likelihood through the stress response (Williams and Andersen, 1988). Unfortunately, few studies (e.g., Andersen, 1988; Andersen and Williams, 1997) have directly assessed the stress response, resulting in a tenuous assumption of its efficacy on the part of researchers (Williams and Andersen, 1998). A study by Andersen (1988) reported that stress increased muscle tension, which in turn may lead to an increase risk for injury. Andersen and Williams (1997) found that athletes with high negative life stress experienced greater attentional focus narrowing (i.e., physiological stress response) and were more likely to incur injuries than non-stressed athletes. The cognitive appraisal component of the stress response may also be affected by life stress, though this relationship has not yet been examined empirically.

Narrative reviews of the life stress and sport injury literature have suggested that the majority of studies support a positive relationship between life stress and injury (see Williams and Andersen, 1998; Williams and Roepke, 1993). A recent meta-analytic review of the life stress injury relationship provided support for a low to moderate positive relationship between life stress and injury (Kontos and Foret, 2001). However, this relationship was only applicable to negative (e.g., demotion in sport, death of a friend) and total (i.e., negative and positive) life stress. In contrast to previous research (Blackwell and McCullagh, 1990; Petrie, 1993) the relationship between positive (e.g., promotion in sport, new friends) life stress and injury was near zero. Therefore, one can infer that a large quantity of life stress and life stress that is perceived as negative by athletes play a greater role in the injury process than does positive life stress. This finding echoed the results of previous research on the role of negative and total life stress in injury in sport (e.g., Passer and Seese, 1983; Smith *et al.,* 1990).

Youth sport presents a unique set of potential stressors that may adversely affect injury outcomes. The pressure to win, and consequently, not lose, is a significant stressor among youth in sport (Smoll and Smith, 1990). The pressure to win at all costs may encourage youth to engage in risk taking behaviors that may lead to injury. The stress related to being successful can result from pressure on young sport participants to maintain status on a team (i.e., starter), gain a scholarship or professional career, or please those around them. Parents are a common source of stress for youth in sport (Scanlan, 1986). This stress can be a result of parents' over-identification with their child's youth sport endeavors. Parents who attempt to live vicariously through their child often place tremendous stress on the outcomes of youth sport, which creates stress for their child. Coaches also have substantial direct contact with youth sport athletes, and can affect their perceptions considerably. A negative coaching style (e.g., punishment, lack of reward, negative reinforcement) adds stress to the youth sport setting. In fact, negative coaching behaviors have been linked directly to an increased risk of injury in youth sport (Kontos, 1995). Although youth sport participants are susceptible to stress from many sources, it is often their ability, or inability, to cope with stress that determines the effects it has on injury outcomes.

5. COPING RESOURCES

Stress is an inevitable part of youth sport. If a youth sport participant does not cope well with stress, their likelihood for injury will increase. Coping can take several forms: social support from family and peers, psychological coping such as stress management, and general coping such as good nutrition (Williams and Andersen, 1998). Regardless of the source, it appears that poor coping resources generally increase the likelihood of injury in sport (Hanson *et al.*, 1992; Petrie, 1992; Williams *et al.*, 1986). Williams and Andersen (1997) found that low social support increased the stress response and subsequent likelihood of injury. Coping is particularly salient for youth sport because so few youth have developed adequate coping resources before entering adulthood. Moreover, many of the potential coping mechanisms used by adults are used infrequently by youth. For example, youth sport participants would benefit from social support from knowledgeable others such as coaches and parents; however, as discussed previously, parents or coaches may be the main sources of stress for many youth sport participant. Although peer social support and coping is available to youth, it may be equally ineffective, as their peers are likely to possess similarly limited coping resources. Coping resources, the effects of stress, and injury outcomes are also influenced by an athlete's personality.

6. PERSONALITY

Much of the early research on psychological factors and injury in sport focused on personality factors (e.g., Lysens *et al.*, 1989; Taerk, 1977). These early studies sought to characterize an 'injury prone' personality type. Although these and subsequent studies failed to uncover any specific 'injury prone' personality, they did provide support for the relationship between certain personality traits and injury in sport (Junge, 2000). For instance, researchers (Backx *et al.*, 1991; Straub, 1982) have suggested that certain athletes are 'high-risk' individuals because they seek sensation in sport. These athletes are subsequently more likely to engage in risk-taking behaviors than athletes who are not 'high-risk'. Smith *et al.* (1992) observed that athletes low in sensation seeking reported more negative life-stress and had higher incidences of injury than those high in sensation seeking. Their findings suggest that sensation seeking (i.e., 'high risk' individuals) athletes, who actively seek out 'high risk' situations, have an inherently greater ability to deal with the stress associated with these situations. In turn, this may predispose sensation seekers to better cope with and prepare for potentially injurious or otherwise dangerous situations, thus limiting their likelihood for injury. Sensation seeking athletes may also engage in 'calculated' or informed risk taking, where contingency plans are developed to proactively deal with potential negative circumstances related to risk taking. However, the relationship between sensation seeking and risk taking behaviors in sport has not been confirmed.

In other research, the propensity for risk taking among certain athletes was found to be a key psychological factor in the determination of injury outcomes in sport (Jackson *et al.*, 1977; Taimela *et al*, 1990). A more recent foray examining personality and injury in sport supported a similar relationship between being 'tough minded' (i.e., assertive, confident, and independent) and incurring more severe injuries (Wittig and Schurr, 1994). The researchers speculated that their findings might have been indicative of 'tough minded' athletes taking more risks than other athletes. These findings are in contrast to the findings regarding sensation seeking mentioned above, and may be reflective of 'uncalculated' risk taking on the part of the athletes in the Wittig and Schurr (1994) study. A direct link between sensation seeking type motives, risk taking behaviors and injury needs to be explored to better determine the interrelationship among these factors. It may be the type of risk taking (i.e., 'calculated' vs. 'uncalculated') that athletes engage in that is most important in determining injury outcomes. Regardless, these findings may be particularly salient among adolescent sport participants because sensation seeking and high risk (e.g., driving fast, drug use) behaviors increase linearly with age in adolescence (Brenner and Collins, 1998). Unfortunately, during the last few years, researchers have all but abandoned personality factors in relation to injury in sport. Research related to risk taking behaviors and perceived risk, however, has begun to emerge as a promising area of inquiry into the psychology of sport injury.

7. PERCEIVED RISK AND RISK TAKING

During the course of any sport event, young athletes are constantly making assessments of the environment. One of the assessments that athletes make pertains to their perceptions of risk of injury, or 'fear of injury'. Researchers have suggested that 'fear of injury' is a specific personality trait (i.e., injury trait anxiety) related to sport trait anxiety (e.g., Kleinert, 2002). From this perspective, injury trait anxiety would be included in the personality component of the stress model of injury. Other researchers, however, contend that perceived risk of injury represents a more situation-specific factor that is based on athletes perceptions of: (a) probability of injury- a cognitive assessment of injury likelihood, (b) worry/fear of injury- an assessment of negative emotion related to being injured, (c) perceived control over injury outcomes, and (d) consequences of injury outcomes (Kontos, 2002; Short *et al.*, 2001). This perspective suggests that perceived risk of injury represents the cognitive appraisal portion of the stress response component of the stress model of injury. Perceived risk of injury is proposed to affect an athlete's decision-making process regarding risk taking behaviors in sport (Kontos, 2000). It is most likely that situation specific perceptions of risk of injury interact with an athlete's sport trait injury anxiety to influence injury outcomes.

Researchers have yet to assess the direct effects of sport injury trait anxiety on the injury process. However, several trends in regard to perceived risk of injury and risk taking have emerged. Namely, a high perceived risk of injury (i.e., probability, worry, and lack of control over injury outcomes) has been linked to increased injury risk (Kontos, 2002). Although researchers have hypothesized an inverse relationship between perceived risk and risk taking, this relationship has not been empirically supported in youth sports (Kontos, 2000). Risk taking has been found to be related to injury in youth in non-sport environments (Potts *et al.*, 1995), however, risk taking has yet to be reliably assessed in youth sport. Perceived risk of injury has also been linked to self-confidence.

8. SELF-CONFIDENCE AND PERCEIVED RISK

According to Bandura (1997), athletes who inaccurately perceive themselves to be high in ability are likely to have inflated confidence (i.e., overconfidence) in attaining desired outcomes in a given situation. Consequently, overconfident athletes may engage in more risk-taking behaviors because they are confident in attaining a positive outcome (i.e., not being injured) from their behaviors. Overconfidence in this context is analogous to perceived invincibility. In research with youth soccer players, Kontos (2000) found that risk taking was highest among overconfident athletes. Overconfident athletes were not, however, at greater risk of injury than other athletes. In contrast, athletes who underestimated their abilities (under-confident) and perceived high risk of injury were at significantly greater risk of injury than other athletes (Kontos, 2000). Short *et al* (2001) reported an inverse relationship between perceived risk and self-confidence among collegiate athletes. Hence, young athletes who have high perceptions of risk appear to lack confidence in their sport skills and are at greater risk of injury in sport.

9. FEAR OF REINJURY

Athletes who return to sport from an injury too early may also be at increased risk for a subsequent injury. The increased risk of injury may be related to athlete's perceptions of the likelihood of potentials outcomes (i.e., reinjury) of their return to sport. Often, these athletes appear to be physically ready to return to sport. Mentally, however, they may lack pre-injury levels of confidence, have a greater fear of injury, and be hesitant in their approach to their sport (Petitpas and Danish, 1995; Williams and Roepke, 1993). Consequently, coaches, parents and athletes should monitor mental, as well as physical aspects of recovery from injury to determine an athlete's overall readiness to return to sport.

10. INTERACTION OF PSYCHOLOGICAL AND OTHER FACTORS

Although psychological factors play a significant role in determining injury in youth sport, these factors typically account for 15-40% of the variance in injury outcomes (Kontos and Foret, 2001; Williams and Andersen, 1998). This finding suggests that psychological factors do not act alone in influencing injury. When determining the risk of injury in youth sport it is important to examine the interactions among maturation/biology, biomechanic, physical/environmental, socio-cultural and psychological factors. For example, as Morano and Malina discuss in Chapter 14, biology (i.e., physical size) and maturity are key factors to consider when determining injury risk in youth sport.

11. INTERACTIVE EFFECTS OF NON-PSYCHOLOGICAL FACTORS ON PERCEIVED RISK

The perceived risk of injury in sport literature provides a good example of the interactive effects of biology/maturation, biomechanic and socio-cultural, and psychological factors on injury in youth sport. For instance, young athletes who are physically larger than their peers appear to be more confident in sports and engage in more risk taking than average or smaller size athletes (Kontos *et al.*, 1999; Kontos, 2000). This relationship appears to be influenced more by maturation status (i.e., early, average, late) than physical size. Specifically, early maturers are more likely than average or late maturers to engage in risk taking behaviors in sport regardless of physical size (Kontos, 2000).

Sex also plays an important role in the risk of injury among youth sport athletes. Males are more confident (often over confident) and perceive less risk, and engage in more risk taking in youth sport than females (Kontos, 2000; 2002). Coaches and parents (i.e., socio-cultural factors) may exacerbate these effects by focusing more attention on skill development among female athletes and less attention on strength and conditioning, two factors that reduce the risk of injury in sport. The socialization of males toward aggression in youth sport may also influence this relationship.

As discussed earlier, overconfident athletes engage in risk taking in sport. The use of protective equipment such as helmets, shin guards, and mouth guards may inflate the confidence of athletes and the likelihood that athletes will engage in reckless or risk behaviors in sport. The added protection afforded by these biomechanic-related devices may reduce perceptions of risk of injury and give athletes a feeling of invincibility. Hence, biomechanic devices designed to minimize the physical risk of injury may result in an increased behavioral risk of injury.

Other factors also must be considered when examining the injury process in youth sport. Biomechanic factors such as the location of females' knee joints relative to their hips (i.e., 'q angle'), an imbalance in strength in the hamstrings compared to the quadriceps, and neuromuscular control (i.e., agility) problems are related to an increased risk of knee injuries for females (Bonci, 1999; Ireland, 1999). Socio-cultural factors such as: the behaviors of significant others (e.g., coaches: Kontos, 1995; Shields *et al.*, 1995); expectations and modeling of aggressive or violent behaviors (Mugno and Feltz, 1985; Stuart and Ebbeck, 1995); and sport-specific norms and expectations such as sanctioned violence in collision sports like rugby, hockey and American football (Shields and Bredemeier, 1995) may also increase the risk of injury in youth sport. The previous examples of the interactions of multiple factors on injury highlight the need for a multidimensional approach to understanding the risk of injury in youth sport.

12. A NEW MULTIDISCIPLINARY FRAMEWORK FOR UNDERSTANDING INJURY IN YOUTH SPORT

As mentioned previously, researchers have focused considerable attention on the psychological factors related to injury in sport (Williams and Andersen, 1998). The stress model of injury is the most commonly used theoretical framework for examining the psychological factors related to sport injury. Although the stress model of injury has provided an empirically valid theoretical framework for examining injury in sport, it was designed for use with adult sport populations. Moreover, the stress model of injury does not consider the myriad of psychobiosocial and other factors affecting the injury process among youth sport participants. As Williams and Andersen noted in their 1998 review and revision of the stress model, researchers should consider non-psychological as well as psychological factors in determining injury outcomes. Hence, a new multidisciplinary revision of the stress model of injury in youth sport is proposed in Figure 2.

The new multidisciplinary model of youth sport injury integrates the basic mechanism and premise of the stress model together with biology/maturation, biomechanic, physical/environmental, and socio-cultural factors to allow for a more comprehensive examination of injury in youth sport. The new model begins with the inherent injury risk associated with a specific sport situation. The inherent injury risk is determined by the sport environment (e.g., sport type, playing conditions), and the biomechanic and physical characteristics of the athlete. The inherent risk leads to a revised stress response, which includes four interactive components: (a) cognitive appraisal (e.g., perceived risk), (b) physiological response, (c) behavioral response (e.g., risk taking), and (d) emotional response (e.g., fear). The stress response is then moderated by three interactive factors: socio-cultural (e.g., coaches, culture) psychological (e.g., personality), and maturation/biology (e.g., sex, maturity). Interventions such as imagery and stress management also moderate the stress response and affect the inherent injury risk. The revised stress response directly determines injury outcomes. Once an injury outcome (e.g., injured vs. uninjured) has occurred, it becomes a previous injury experience and affects the inherent injury risk, and moderates the athlete's subsequent stress response. This feedback loop continues to evolve as the athlete experiences injuries both directly and indirectly (i.e., vicariously through others or the media). The multidisciplinary model of injury in youth sport offers researchers and practitioners alike a comprehensive framework from which to assess injury risk in youth sport.

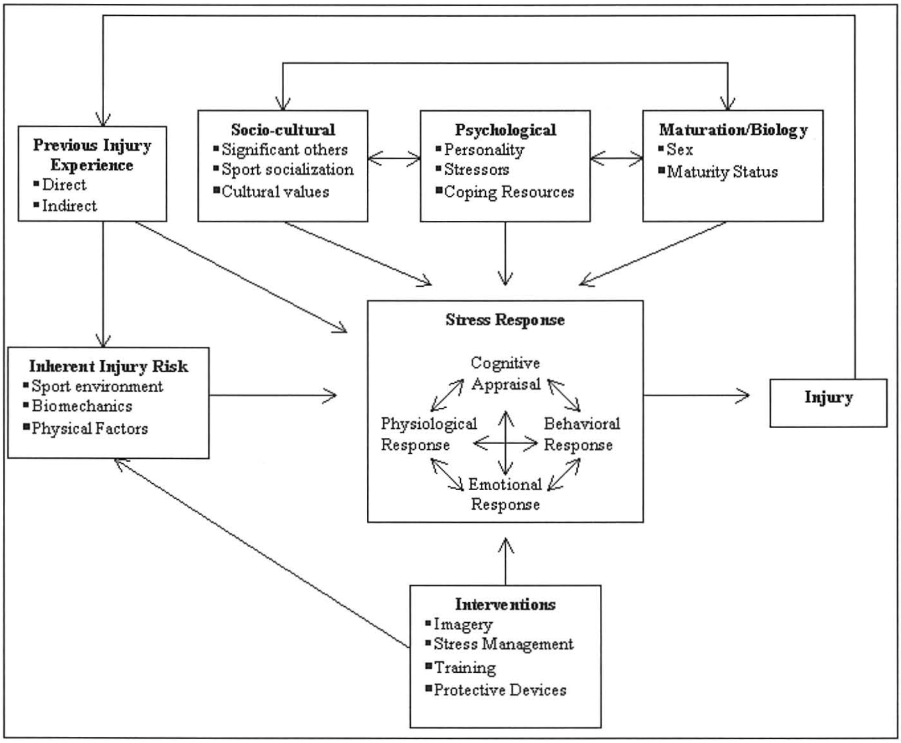

Figure 2. A multidisciplinary revision of the stress model of injury in youth sport.

13. CONCLUSION

Psychological factors appear to play a significant role in the determination of injury among youth sport participants. Research has supported strong relationships between factors such as perceived risk (Kontos, 2000; Short *et al.*, 2001) and life stress (Kontos and Foret, 2001; Williams and Andersen, 1998; Williams and Roepke, 1993), and injury. However, additional psychological (e.g., sensation seeking, injury trait anxiety) and other (e.g., maturation, socio-cultural) factors affecting the potential for injury among youth sport participants need to be examined. Psychological and other factors related to injury in youth sport should be investigated using an interactional approach such as the one presented earlier in the multidisciplinary model of youth sport injury. Future research should also compare the effects of these factors on youth- and adolescent-aged populations, as developmental differences may influence injury outcomes. Finally, the results of research on the psychological factors related to injury in youth sport should ultimately be used to develop prevention strategies such as behavioral guidelines, risk awareness, stress reduction and increased self-confidence.

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GYMNAST WRIST: THE ULNAR VARIANCE PHENOMENON*

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1. INTRODUCTION

Nowadays, elite sports for children and youth becomes more and more a public phenomenon. The extreme training demands and controlling young athletes by coaches, often with approval of the parents, together with changes in expectations of performance at top levels, has resulted in public and medical concerns. (Bar-Or, 1996; Ryan, 1995) This is especially true in sports as gymnastics, in which a prepubertal physique is a prerequisite for top level gymnastic achievements. (Claessens, 1999) Further, the demands of artistic gymnastics for females have also changed, eg requirements for more difficult routines, year-round training, enhanced mental stress, and so on (Gould, 2001; Jemni *et al.*, 2001; Normile, 1996; Ryan, 1995).

The significant growth and popularity of women's gymnastics became more and more evident after the 1972 and 1976 Olympics, where stars as Olga Korbut and Nadia Comaneci introduced the world, via the media, to this artistic sport (Ryan, 1995). Accompanying this popularity has been the increasingly dominant performance of younger, smaller-sized gymnasts (Caine *et al.*, 1996; Claessens, 1999). Average ages, and heights and weights of female gymnasts participating at Olympic and World competitions have declined over the past 20 to 30 years (Claessens, 1999). Over a period of about 25 years, the average chronological age of elite female gymnasts declined by 6 years. Secular declines in mean heights and weights parallel the decrease in chronological age. Over the same period, mean height have declined by 4 to 5 cm. The secular decline in height is accompanied by a dramatic reduction in mean weight of about 8 to 9 kg (Claessens, 1999; Claessens *et al.*, 1991). Comparable declines in age, height and weight were also observed in artistic female gymnasts from the United States competing at the 1992 Olympics which were 6% younger, 10% shorter, and 22% lighter compared to their 1976 counterparts (Ryan, 1995). The majority of elite gymnasts also tend to be later-maturing individuals (Claessens, 1999; Malina, 1999, 2001). In general, present-day elite gymnastics has evolved to favor the body of a child in

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* Based on a presentation at the Symposium *Science in Artistic Gymnastics*, held in Ghent, Belgium, October 27, 2001. (Claessens, 2001)

contrast to that of a maturing adolescent or young adult (Claessens, 1999). These observations can be in large part be attributed to 'selection' based on the direct biomechanical advantages of a prepubertal physique that include increased strength/weight ratio, greater stability, and decreased moments of inertia. Also, in sports in which performance is subjectively scored, as in gymnastics, physical characteristics in addition to skill, may have added significantly for success (Claessens, 1999; Ryan, 1995).

Not surprisingly, whereas the average age and size of competitive gymnasts have decreased, the difficulty of maneuvres practiced and performed has increased. Frequency, duration, and intensity of training also have increased. Elite-level gymnasts, for example, are reported to train around 40 h/week, 5-6 days/week, the whole year around. On avarage, these gymnasts may exercise 700 to 1300 elements per day, which correspond to 220 000 to 400 000 elements per year (Caine *et al.*, 1997). These extremely high training demands and changes in expectations of the sport at elite levels (Normile, 1996) has resulted in both public and medical concerns, especially from an auxological point of view (Claessens, 1999; Malina, 2001). It may be postulated that these very young and immature growing athletes are repeatly subject to numerous microtrauma in general, and more specifically, to chronic, long-term accumulative 'overuse' injuries, caused by strenuous, repetitive loads. Epidemiologic research of injury patterns in male and female gymnasts has been studied extensively by several authors, and reviewed by Caine and co-workers (1996).

Unlike most other sports, gymnastics requires use of the upper extremities as weight-bearing limbs, causing high-impact loads to be distributed through the elbows and wrists (Koh *et al.*, 1992; Markolf *et al.*, 1990). It is not unexpected that injury occurs in these regions (Caine *et al.*, 1996). Among others, wrist pain is often viewed in gymnasts as a result of epiphysial trauma and related changes caused by repetitive gymnastic loading mainly of the distal end of the radius as its interface with the carpals, as claimed by some authors (reviewed by Caine *et al.*, 1997). Further on, some authors claim that repetitive injury to the radial epiphysis may inhibit normal growth of the radius resulting in a '*positive ulnar variance*' (Caine *et al.*, 1996, 1997).

The aim of this study is to review the available research concerning the ulnar variance phenomenon as it is connected to the female gymnast.

2. ULNAR-VARIANCE

Ulnar variance refers to the relative positioning of the distal end of the ulna relative to the distal end of the radius. If the distal end of the ulna is more distally located as compared to the distal end of the radius, then the term *positive ulnar variance* (or ulnar overgrowth) is used. When the opposite is seen, i.e. the distal end of the ulna is more proximal located as compared to the distal end of the radius, the phenomenon is called *negative ulnar variance* (Hafner *et al.*, 1989). Ulnar variance is mostly determined on postero-anterior radiographs of the hand and wrist, whereby several measuring methods are at hand. Different techniques has to be used for mature and immature wrists (Hafner *et al.*, 1989; Kristensen *et al.*, 1986; Palmer *et al.*, 1982: Steyers and Blair, 1989).

3. FINDINGS FROM CASE REPORTS AND CROSS-SECTIONAL STUDIES

In general, it has been proposed by several authors that the repetive stress experienced by the skeletally immature wrist during gymnastics training (especially in the young female elite gymnast) may lead to the development of wrist pain, partial arrest of the distal radial growth plate, and the subsequent development of positive ulnar variance. This proposal suggests thus a dose-response relationship, i.e. the closure of the radial growth plate, caused by the gymnastic training load, results in a positive ulnar variance. This line of reasoning is largely based on 'patients' or 'case'-reports, i.e. those individuals who present themselves to a clinic with wrist pain, and on cross-sectional srudies in which a relatively small number of both non-elite and elite gymnasts were studied (Albanese *et al.*, 1989; Aldridge, 1987; Carter and Aldridge, 1988; Chang *et al.*, 1995; DiFiori *et al.*,1997; Mandelbaum *et al.*, 1989). Although, on average, a positive ulnar variance in most studies could be observed, results were contradictory and controversial conclusions were made. Also, because of the small sample sizes and the selective recruitment, the subjects under study were not necessary representative of the elite gymnastic population. To our knowledge, up till now, only one study is carried out in which a representative sample of outstanding female gymnasts was undertaken (Claessens *et al.*, 1996; De Smet *et al.*, 1994). Ulnar variance was obtained in 201 female gymnasts, all participants at the 24th World Championships Artistic Gymnastics, held at Rotterdam, The Netherlands, October 1987 (Claessens *et al.*, 1991). The gymnasts under study came from 27 (from in total 31) countries. Based on the final results for total team scores, the four teams that declined ranked 2nd, 13th, 15th, and 19th. It can thus be said that the gymnasts under study were a representative sample of the elite female gymnastic population as demonstrated by the number of subjects studied (n=201), high level of training (on average 27 hours per week, varying from 13 to 48 hours per week), competition level (world championships), and representativess of nationalities. A negative mean value for ulnar variance (Mean= -1.4$\pm$2.6 mm) was obtained, demonstrating thus a negative ulnar variance in this high elite female gymnasts. Further on, it was demonstrated that no relationship between ulnar variance on the one hand, and training and competition level on the other hand could be observed. Based on these results, authors could not support the dose-response relationship. These results were in accordance with the data of DiFiori *et al.* (1997) in non elite female gymnasts.

4. RESULTS FROM LONGITUDINAL STUDIES

It is demonstrated that results from different studies give controversial conclusions. This is not directly surprising, because the design of these investigations, i.e. cross-sectionnally, does not allow to draw a real cause and effect relationship. Thus, well-controlled longitudinal studies, in which elite gymnasts were followed for several years, were needed, in which the dose-response relationship between gymnastic training and the ulnar variance phenomenon can be studied in a more effective way.

In a longitudinal study, 36 female gymnasts were annually followed for four or five occasions, with a total of 158 observations (Claessens *et al.*, 1997). At the first observation, the age of the girls varied between 6 and 14 year. According to their training level (based on the total hours of gymnastic training per week) the total group could be divided in three subgroups: (1) a 'top-level' group (n=13, with 15 hours training / week); (2) a 'subtop' group (n=13, with about 5 to 7 hours training / week), and (3) a 'recreational' group (n=10, with about 1 to 2 hours training / week). Besides stature and weight, ulnar variance was determined according to the method of Hafner *et al.* (1989) for immature wrists. Results for ulnar variance demonstrated that for all age categories a negative value was observed, which means that the distal end of the radius exceeds the distal end of the ulna. With increasing age, this negative ulnar variance became more pronounced, the mean varying from –3.4 mm to –6.5 mm. These results were rather uncommon and this from two viewpoints. Firstly, compared to reference girls (Hafner *et al.*, 1989), where a relatively stable negative ulnar variance pattern can be observed throughout the growth period, varying between –2.5 mm at the age of 6 year and –2.8 mm at the age of 15 year; whereas in the gymnasts' sample, an increase in negative ulnar variance could be obeserved throughout the period studied. Secondly, based on the available literature, a rather 'positive ulnar variance' was expected. However, this was not the case in this longitudinal study, indicating that, in the sample studied, gymnastic training seems not to have a negative impact on the ulnar variance phenomenon. This observation was analyzed more in detail in that way, that two extreme groups with different training loads, were also compared. Results from these analyses revealed that no statistical differences in ulnar variance between the 'top-level' and the 'recreational' groups could be observed. Based on the results and within the limitations of their study, Claessens and co-workers (1997) came to the conclusion that the ulnar variance pattern is not directly caused by the gymnastic training load, and could not support the dose-response relationship. It is, however, clear that more longitudinal and intervention studies are needed before more exclusive interpretations can be made.

5. FACTORS RELATED TO THE ULNAR VARIANCE PHENOMENON

5.1. Methodological concerns

Different methods are at hand to measure ulnar variance in both mature and immature wrists (Hafner *et al.*, 1989; Kristensen *et al.*, 1986; Palmer *et al.*, 1982). As a result discrepancies between results were obtained using different techniques and data from different studies are not directly comparable (Steyers and Blair, 1989).

In most studies ulnar variance is determined on unilateral radiographs arbitrarily chosen. However, some authors (Claessens *et al.*, 1998; DiFiori *et al.*, 1997; Freedman *et al.*, 1998) have focussed on the problem of right versus left symmetry of ulnar variance. The results of these studies, however, are not unequivocal. DiFiori *et al.* (1997) and Freedman *et al.* (1998) have demonstrated that an individual's ulnar variance is not uniformly symmetrical with the consequence that results who were obtained from different wrists are not directly comparable. In contrast, in a study on 8 – 14 year old female gymnasts, Claessens *et al.* (1998) did not find a significant difference between ulnar variance taken from right and left radiographs. Also, differences in ulnar variance could not be observed between the dominant and non-dominant wrists, as determined by the rotational direction a wheel is turned.

5.2. Wrist pain and ulnar variance

Several authors claim that wrist pain in gymnasts is associated with a positive ulnar variance (Caine *et al.*, 1996). However, based on data gathered on 27 girls and 17 boys, who could be classified as non-elite gymnasts, training on average 11.9 hours per week, DiFiori *et al.* (1997) did not find a significant association between ulnar variance and wrist pain. There was also no significant association between positive radiographic findings and ulnar variance.

5.3. Maturity status and ulnar variance

It is often argued that the less mature the gymnast, the more negative the impact of gymnastic training on the radial growth plate, and as a consequence, a more positive ulnar variance is observed. However, based on data gathered on 156 world-top immature female gymnasts, no significant relationship was found between skeletal age and ulnar variance, $r=+0.16$ (Claessens *et al.*, 1996). When the data were analysed more in detail, it was clearly demonstrated that ulnar overgrowth was not associated with advanced maturity status of the radius or earlier epiphyseo-diaphyseal fusion; rather, ulnar overgrowth was apparently associated with more advanced maturity status of the ulna (Beunen *et al.*, 1999).

5.4. Gymnastic training load and ulnar variance

In most studies, especially case-reports, a dose-response relationship between training and ulnar variance is suggested. Thus, the higher the gymnasts' training and/or competition level, the more pronounced positive ulnar variance. This cause-effect relationship, however, is not equivocal concluded by all authors and need further consideration. In a study on a representative sample of outstanding (participants world championships) female gymnasts, Claessens *et al.* (1996) did not find any significant correlation between training status and competition scores on the one hand, and ulnar variance on the other hand, correlation values varying from r=-0.11 (r between starting age and ulnar variance) and r=+0.15 (r between competition score uneven bars and ulnar variance). Also, DiFiori *et al.* (1997) did not find a significant association between ulnar variance and training history in 44 non-elite male and female gymnasts, aged 5.8 – 15.8 years. Also, based on data gathered on 36 female gymnasts who were followed longitudinally for four years, Claessens *et al.* (1997) could not demonstrate a significant influence of gymnastics training load and the ulnar variance phenomenon.

5.5. Body build and ulnar variance

It can be hypothesized that an 'overweight' or 'overfat' body, or a physique not fully suited for gymnastics, will be more at risk for overload or overuse injuries than a physique that is appropriate for the sport. It can thus be argued that the 'heavier' the gymnast, the higher the mechanical load on the gymnasts' wrists, resulting in a more pronounced positive ulnar variance. With the exception of some studies (Claessens *et al*, 1996; Boogaerts, 2002), most of the available studies of ulnar variance in gymnasts has taken the bodily characteristics of the subjects and/or patients into account. It is, however, clearly demonstrated, that female gymnasts competing at the elite level with a body physique characterized as relatively tall and a high lean body mass, not fat, are at greater risk in developing a positive ulnar variance.

5.6. Basic motor abilities and ulnar variance

To our knowledge, little is known if there is any relationship between the basic motor capacity or physical fitness condition of the gymnast and ulnar variance. However, it can be argued that the relative positioning of the ulna to the radius can be influenced by some motor abilities, in general, or especially at the wrist region (e.g. strength and flexibility characteristics of the wrist, fingers, and so on). Up till now, in none of the published material concerning ulnar variance this relationship was investigated. Very recently, this relationship was studied in a group (n=16) of 16-year old (SD=2.0) sub-top female gymnasts. (Vandenbussche, 2002) Significant correlations between ulnar variance and some motor capacities were found: with hyper extension of the fingers (r=+ 0.65); and with hyper extension of the elbow (r=+0.52). The results of this preliminary study suggest that more flexible gymnasts are at greater risk in developing a positive ulnar variance.

6. CONCLUSIONS

Based on the available literature of the ulnar variance in female gymnasts it can be concluded that, compared to the reference values, the observed positive ulnar variance in gymnasts is less 'dramatic' than originally stated. We support Rowlands' comment in his 'Editor's Notes' that "The available information is scant, and much more research is needed, but so far most of these seem to be largely false alarms ... The psyche of the highly trained athlete, on the other hand, may be more susceptible to injury than the epiphysis" (Rowland, 1993, p. 300). However, the observed data from the literature poses at least the possibility that growth can be affected and the condition must certainty be taken seriously. More research is needed, especially well designed longitudinal studies taking into account a broad spectrum of factors which are connected to the ulnar variance phenomenon. Finally, the importance of optimal training programs, supervised by well-educated coaches, together with the guidance of the young gymnast by a highly qualified medical team, cannot be stressed enough.

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