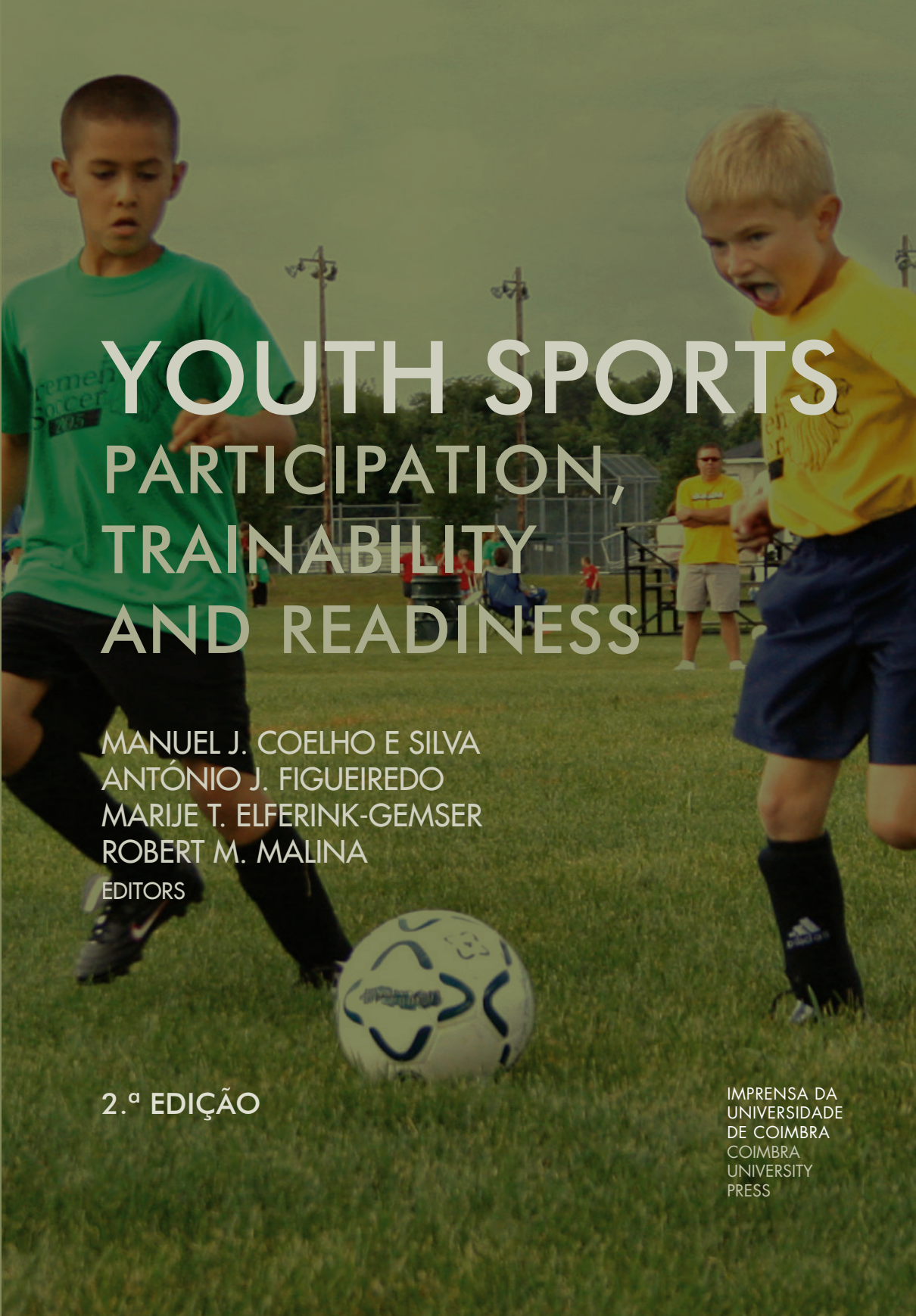

YOUTH SPORTS
PARTICIPATION, TRAINABILITY AND READINESS

MANUEL J. COELHO E SILVA
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MARIJE T. ELFERINK-GEMSER
ROBERT M. MALINA
EDITORS

2.ª EDIÇÃO

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Participation in sports is a major feature of daily living for children and adolescents in many countries of the world. Structures of organized programs vary within and among countries. Likewise, sport offerings and values attached to these sports vary with cultural context. Sport is also a primary source of physical activity for many children and adolescents, and is an arena in which personal and interpersonal values and behaviors are developed and nurtured. Key players in these important functions of sport are peers, coaches and parents. The volume is aimed primarily for students of Physical Education and Sport Sciences, coaches, trainers, parents and others involved in youth sport programs and in the preparation of young athletes. The contents have application to a variety of cultural contexts given the near universality of sport for youth throughout the world. 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 by educating adults who work with them in the context of sport.

Robert M Malina

This book addresses relevant issues within the scope of organized sports. Chapters are written by distinguished contributors with a comprehensive list of topics that under the coordination, the leadership and expertise of the editors, provided the scientific literature with an unique and in depth analysis of social, biological, cultural and related interactions. This book is published by the renowned University of Coimbra. The same University that only a short time ago began to offer a course in Physical Education and Sport under the intellectual and scientific leadership of Francisco Sobral Leal. His work in Portugal is both unique and pioneering. Here he has been able to be influential. This book, due to its quality and the nature of its topics, is thus a fine tribute to his work and culture of interaction. A tribute of science in the name of knowledge.

Luis Bettencourt Sardinha

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A NOTE FROM THE EDITORS

Participation in sports is a major feature of daily living for children and adolescents in many countries of the world. Structures of organized programs vary within and among countries. Likewise, sport offerings and values attached to these sports vary with cultural context. Sport is also important in the primary demands that face all children and adolescents, i.e., the business of growing, maturing and developing. Sport is also 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. Key players in these important functions of sport are peers, coaches and parents.

The volume is aimed primarily for students of Physical Education and Sport Sciences, coaches, trainers, parents and others involved in youth sport programs and in the preparation of young athletes. The contents have application to 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 and adolescent with the needs of a child and adolescent. The demands of sport are superimposed on the biological and behavioral demands placed upon children and adolescents. All too often this is overlooked, especially at the more elite levels of youth sport, where the young talented athlete is often viewed as a commodity. 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 by educating adults who work with them in the context of sport.

The second edition of Youth Sports is divided into two volumes. Volume I includes chapters in two parts. The first focuses on Participation – statistics, benefits and risks, motivation, coaching values, and parents. The second part focuses on Trainability, Readiness and Injuries – the effects of training on growth, responsiveness to training for sport, physiological dimensions of training, and risk factors for injury. Volume 2 includes chapters in three parts. The first focuses on growth and maturation - young athletes in general, young athletes participating in soccer, swimming and artistic gymnastics. The second focuses on Talent – specifically talented young athletes in tennis and soccer and physiological characteristics of elite adolescent athletes in several sport. The third part focuses on Training – quality of training experiences, tactical training and talent coaches. The two volumes bring together research-based knowledge and understanding from the perspectives of the biomedical (human biology), social and sport sciences. Readers are thus provided with a wide spectrum of contemporary insights

relating to the participation of children and youth in sports, on one hand, and sport developmental processes, on the other. We believe that the compilation of chapters presents a reasonably comprehensive overview of topics and issues in contemporary youth sports research.

The chapters comprising the two volumes were prepared by senior researchers many of whom were working with their young colleagues, often beginning professors and students working on advanced degrees. Contributors come from nine different countries in Europe (Belgium, Czech Republic, Portugal, The Netherlands, United Kingdom) and the Americas (Brazil, Canada, Mexico, United States). We are sad to announce the deaths of three individuals who contributed to the first edition, Eyra E Cardenas Barahona from Escuela Nacional de Antropologia e Historia in Mexico City; Martin J Lee from the Chelsea School Research Centre of the University of Brighton in the United Kingdom; and Thomas Reilly from the Research Institute for Sport and Exercise Sciences of Liverpool John Moores University in the United Kingdom. Eyra was a physical anthropologist with a genuine interest in the study of sport while Martin and Tom were students of the sports sciences. All three will be dearly missed as friends and as scholars.

Manuel J Coelho e Silva
António J Figueiredo
Marije T Elferink-Gemser
Robert M Malina

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, Antonio, Marije 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
Loughborough University, UK

FOREWORD

In the Netherlands, sports are considered important for all but especially for children and youth. In our current policy document on sports for all, three main themes are delineated: 'healthy through sports', 'participation through sports' and 'sports to the top'. In other words, sports are considered important factors in both health promotion and as a way toward social integration. Expert athletes occupy a unique position in our country because of the values they represent in terms of role modeling. or many children and youth, expert athletes are heroes and this positively influences their participation in sports. An ambition of the Dutch Olympic Committee is that The Netherlands obtain a permanent top ten position in the world of sports. Furthermore, we strive for at least 75% of our population to be active in sports. Participation in sports is embraced by Dutch sports associations, the Olympic Committee and Dutch government. Therefore, we invest in a pleasant social climate in sports, schooling of trainers, research and talent development; not only for adults but also explicitly for our children and youth. In recognition of many beneficial values of sports, The Netherlands plan to stand for candidacy to host the Olympic Games in 2028.

Erica Terpstra
*President of the Dutch Olympic Committee NOC*NSF*

FOREWORD

This book addresses relevant issues related to participation, readiness, auxiology and talent in children and youth within the scope of organized sports. Twenty eight chapters are written by distinguished contributors with a comprehensive list of topics that under the coordination, the leadership and expertise of the editors, provided the scientific literature with an unique and in depth analysis of social, biological, cultural and related interactions. This book is published by the renowned University of Coimbra. The same University that only a short time ago began to offer a course in Physical Education and Sport under the intellectual and scientific leadership of Francisco Sobral Leal. Most of the topics in this book, in the fields of education and research, are indelibly associated with the pioneering work of Francisco Sobral Leal in the Portuguese academic world.

I confess that, although honoured and despite a personal acquaintance that dates back to the early days of democracy in Portugal, it is not easy for me to find words to describe the merit of the vision of a man who has always appreciated sport and expressed in it all his extensive culture. However it is an obligation that gives me pleasure, given the great ease with which he has reflected, argued and influenced the ever timid transition from the idea of the individual subject to the democratic subject, thus offering access to an important social dimension that qualifies the human being without any determinism. That qualifies people for their actions according to circumstances or instants. After all, not very different from the typical conduct of the athlete. Like an athlete pushing his limits, Francisco Sobral Leal is a man of interactions. Which is perhaps more difficult in different areas of knowledge. But also more appealing. At the forefront of the scientific and technological advances to explore and understand the large, open and dynamic topics dedicated to fast-growing and highly competitive domain of sport science in society. The challenge of a deeper understanding, and meaningful information based on work across disciplines, of several processes that are involved in youth health and sports performance. For this reason, his restless thinking soon led him towards highly selective international horizons of knowledge, without however dispensing with constant critical virtuality towards the superficial mechanical attitudes of certain ways of describing reality. He has pursued a biosocial path to attempt to describe and explain the reality of sport for children and young people – the foundations of sports performance among children and adolescents. Colleagues and students have been influenced by the difficult combination of disciplined method with ingenuity of thought or the virtuosity of the brilliant idea. From a combination of analytical dogmatic thought with reflection of the utmost competence. He has always adopted a seductive empathy of thought based on confidence in

his control of method and the uncertainty of the future arising from ideals and original scientific formulations. He has mobilised and motivated students. Directly or indirectly, implicitly or explicitly, several academic careers in Portugal have been influenced by his energetic, sometimes even voluble, thinking. He has reflected and written like no one else on youth sport, as well as on most of the great social and cultural movement that is sport. To such an extent that most of his original contributions and writings are still unquestionably topical.

In sport science, Francisco Sobral Leal's work in Portugal is both unique and pioneering. Here he has been able to overcome circumstances and to be influential. This book, due to its quality and the nature of its topics, is thus a fine tribute to his work and culture of interaction. A tribute of science in the name of knowledge.

Luis Bettencourt Sardinha

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Part 1:

PARTICIPATION

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CHAPTER 1: ORGANIZED YOUTH SPORTS – background, trends, benefits and risks

Robert M Malina

INTRODUCTION

Sport is perhaps the most visible form of physical activity and is also a primary context for activity for the majority of youth of both sexes. Youth also generally identify physical activity as sport.

Sport participation also has high social valence which is evident in the fact that participation in sport is a feature of daily living for many children and adolescents the world over. Further, the number of adolescents competing in sports at national and international levels continues to increase and significant numbers of children and adolescents of both sexes begin systematic training and specialization in a sport at relatively young ages with the goal of attaining elite status. The success of youth at elite levels of sport, which is in reality a very small proportion of participants, highlights the need to distinguish discussion of youth sport between the overwhelming majority who participate and never attain elite levels and the highly visible talented minority. Unfortunately, attention and often resources, as well as commentaries in the print and electronic media, focus on this exceptional minority!

There is a need to better understand the role of organized sport in the lives of youth - the general population of children and adolescents who fill the rosters of youth sports programs throughout the world. Organized sport is only one of many demands in the daily lives of children and adolescents. Demands associated with family, friends, school, study, play, non-sport interests, among others, are realities of childhood and adolescence. These demands are superimposed on the process of "growing up" – physical growth, biological maturation and behavioral development. Where does sport fit into the process of "growing up"? Or, where does sport fit into the daily lives of children and adolescents?

On the other hand, there is also a need to better understand the role of sport in the lives of youth aspiring for elite status. Talented young athletes are a select group which differs from the general population in many domains. Nevertheless, they are children and adolescents with the needs of children and adolescents!

"Growing Up"

The processes underlying growth, maturation and development comprise the universal business of "growing up". These terms are often treated as the same; yet, they are three distinct tasks in the daily lives of children and youth for approximately the first two decades of life (Malina et al., 2004). Details of the three processes are discussed in Chapter 15 (Volume 2). Of importance to those who work with young athletes is the need to recognize that the three processes, growth, maturation and development, occur simultaneously and interact to influence self-concept, self-esteem, body image and perceived competence and also skills and behaviors related to a sport or sport discipline. The three processes vary considerably within and among individuals, especially during the adolescent growth spurt and sexual maturation. The demands of sport are superimposed upon those associated with normal growth, maturation and development. A mismatch between demands of a sport, which are largely regulated by adults, and those of normal growth, maturation and development may be a source of stress among young athletes.

Historical Roots and Types of Programs

Sport can be informal or formal. Informal or "pick-up" sports are neighborhood competitions organized by and for children. They include the many street, lot and/or playground activities based on major sports, for example, street football (soccer), stickball (modification of baseball), street (roller) hockey, two on two basketball, and any number of ball games adapted by children to local neighborhood conditions. Informal sports have historically been a part of childhood and adolescence although the nature of the activities varied with cultural settings and changed over time.

Formal sports for youth, on the other hand, are organized which implies the presence of a coach and regular practices and competitions during the course of a season. Using the United States as an example, organized sport activities and eventually competitions for children and adolescents had their roots in two developments related to child welfare late in rapidly growing cities in the late 19th and early 20th centuries. The first was concern for the behavior of boys, specifically delinquency, and the second was the play movement and its concern with keeping children busy during free time. Sport activities were used to occupy the leisure time of boys and to keep them out of trouble. Some organized sport programs has their origins in the 1920s and 1930s. They were largely community based, including churches. Baseball and American football were the common sports. School sport also emerged at

the same time in several parts of the country to meet the interests primarily of boys. Of interest, inter- and intra-school sport programs had their origins in student organizations and were eventually co-opted by school administrators.

Organized youth sports as we know them today, especially children as young as 5 or 6 years of age, are relatively recent. Although sport competitions were organized in several cities, the founding of Little League Baseball in Williamsport, Pennsylvania, in 1939 by Carl Stotz was perhaps the most important event in the spread of community-based organized youth sports (Stotz and Baldwin, 1952). World War II slowed the development of Little League Baseball, but it rapidly expanded in association with the economic prosperity after the war and the development of suburbs around major United States cities. Inter-school sport competition within and between communities expanded with rapid population growth of the suburbs in the 1960s. From these relatively humble beginnings, organized youth sports have become, for better or worse, a major feature in the daily lives of youth in the United States.

It is reasonable to assume similar trends in the origins of youth sports programs in different areas or countries of the world. They likely have their origins in the historical roots of the more popular sports such as soccer (football) and in country-specific programs of physical education. The organizational nature of youth sport programs also varies compared to those in the United States.

Organized youth sport programs vary considerably and several types can be identified. Agency-sponsored programs youth sports programs are perhaps the most visible. They are sponsored by independent organizations which offer competitions in a variety of sports, e.g., Little League baseball, Pop Warner football (America), Police Athletic League track clubs, more recently YMCA soccer, and others. Agency-sponsored programs often involve a seasonal fee for participants. Recreational sport programs are community based and vary considerably in structure. In larger cities, for example, recreational basketball leagues are often highly structured. School sport programs are also community based. Interscholastic or inter-school competitive sport is currently the dominant program; intramural or within-school programs are very limited in most communities. Both recreational and school sport programs are publicly funded. Sport-specific clubs and in some cases academies are more recent forms of organized sport for youth. Focus is ordinarily on a single sport and participation is fee based. Most visible clubs sports are gymnastics, figure skating, swimming and tennis; more recently, youth soccer has adopted the club model. Although clubs are often aimed at the general population of youth, current emphasis is more often on the talented.

In contrast, sport programs for youth in other areas of the world vary considerably in structure and operation. Sport federations generally have national governing bodies and have a top-down approach in sport from the elite or national teams to the local level. Sport clubs offer programs from the local to the professional levels and many have academy programs for the popular sports. Other sport programs for youth are found in schools which often have sport clubs and competitions, in communities which include sport programs for the general population, and in commercial clubs, i.e., for profit, which may be largely recreational.

Trends in Sport Participation

Trends in sport participation with age during childhood and adolescence vary among surveys and countries. Data are lacking globally and current interest is more focused on monitoring physical activity and inactivity. Variation in statistics reflects in part problems related to measurement and definition, and in the structure of sport programs in different countries. In the United States, sport participation statistics are driven in part by the sporting goods industry and of course the extensive interscholastic sport programs in American high schools.

The National Council of Youth Sports (2001, 2008) reported a slight increase in youth participants ~6-18 years of age from 38.3 million in 2000 to 40.0 million in 2008. The estimates approximated 73% and 76%, respectively, of kindergarten through grade 12 (high school) enrollments in the United States. More boys participated in sport (63%, 66%) than girls (37%, 34%) in 2000 and 2008, respectively.

The Sporting Goods Manufacturers' Association (2001) reported that 54% of youth 6-17 years of age participated in at least one organized team sport in 2000. This figure translated to about 26 million youth 6-17 years. Of interest, 44% of youth played only one team sport; does this represent a trend to early specialization? On the other hand, 30% played two sports and 26% played three or more sports. Statistics of the Sporting Goods Manufacturers' Association for 2005 (as reported in Farrey, 2008) indicated an almost identical estimate, 26 million youth 6-17 years of age (54%) played at least one team sport. On the other hand, an estimated 10 million youth played only in a non-organized team sport (21% of the 6-17 year population) and 12 million (25%) did not participate in any team sport. Compared to 1990, estimated numbers of participants in basketball, softball and baseball in 2005 declined while the number of participants in soccer increased (Farrey, 2008).

The National Federation of State High School Associations also keeps statistics on participation in interscholastic sport in the United States. In the 2005-2006 school year, an estimated 7.16 million high school youth in grades 9-12 participated in interscholastic sport activities, about 59% males and 41% females (National Federation of State High School Associations, 2006). The estimate includes more than 45 competitive activities, but the majority of participants is in five sports. Among boys the five sports accounting for 71% of all participants were American football (1,071,775), basketball (546,335), track and field (533,985), baseball (470,671) and soccer (358,935). The five sports accounting for 67% of all female participants were basketball (452,929), track and field (439,200), volleyball (390,034), fast pitch softball (369,094) and soccer (321,555). In all likelihood, the numbers are to some extent an overestimation. In smaller communities, many youth participate in multiple sports. For example, in a rural high school with a grade 9-12 enrollment of 310 students, 126 students (41%) accounted for "239" participants in interscholastic sport. Among 82 boys, 48% participated in two or three sports while 8% participated in four sports; among 44 girls, 52% participated in two or three sports (Malina, unpublished data).

Sport programs vary among countries, in accessibility and cost, and in degree of sport specialization and participant selectivity (Heinemann, 1999). In addition, data for other countries use a variety of estimation strategies. Sport England (2003) surveyed a sample of 3028 youth in school years 2-11 (approximately 6-16 years of age). Parents completed a questionnaire for those in years 2-6, while youth in years 7-11 completed the questionnaire. Frequent participation in sport out of school lessons was defined as at least 10 times per year. Estimated numbers of participants are based on the number of children 6-16 years in all schools in August 2002 (www.dfes.gov.uk, Statistics of Education 2003). The percentages of boys reporting frequent participation in sport and estimated numbers were as follows: team games 68% (2.3 million), swimming and diving 48% (1.6 million), athletics and gymnastics 43% (1.4 million) and racket sports 33% (1.1 million). Corresponding estimates for girls were: swimming and diving 55% (1.8 million), athletics and gymnastics 48% (1.5 million), team games 39% (1.3 million), racket games 28% (0.9 million), and dance and ice skating 26% (0.8 million). The data for England also include a category labeled outdoor adventure sports which attracted 62% of boys (2.1 million) and 57% of girls (1.8 million). Sport out of lessons was done in several settings: youth clubs or other organizations (55%), sport club outside school (43%) and extracurricular school programs (42%).

Among Australian youth, about 1.6 million children 5-14 years of age participated in school-, club- or association-sponsored sport outside of school hours in 2000 (Australian Bureau of Statistics, 2003). More males participated than females, and the most popular sports were soccer, swimming, Australian

rules football and cricket among boys and netball, swimming, tennis and basketball among girls.

Sport participation among youth varies with age. Among American youth in the late 1980s, there was a steady decline from 10 to 18 years in participation or the intention to participate in organized sport outside of school (Ewing and Seefeldt, 1989). The trend for team sports also suggested a slight decline in later adolescence compared to younger ages among American youth. The proportion of participants in team sports reported by the Sporting Goods Manufacturers Association (2001) was as follows: 6-8 years (24%), 9-11 years (27%), 12-14 years (28%), and 15-17 years (21%). The decline with age comes as no surprise as selectivity increases with age for most sports and interests of youth change.

Change in participation with age across childhood and adolescence shows variation by country; several samples will suffice. Daily participation in sport club training declined from 9 to 21 years, while participation twice per week declined from 12 to 18 years among Finnish youth (Telama and Yang, 2000). The percentage of Italian youth in 2000 who regularly practiced sport increased from 48% at 6-10 years to 53% at 11-14 years and then declines to 41% at 15-19 years (Istituto Nazionale di Statistica, 2005). Among Australian youth, participation in organized sport peaked at 11 years and then declined through 14 years of age (Australian Bureau of Statistics, 2003).

In contrast, limited data indicate no adolescent decline. A sport participation score increased from 10 to 18 years in a national sample of Portuguese boys and girls (Seabra et al., 2007), while in a small sample of Dutch adolescents followed longitudinally from 13 to 16 years and then observed at 21 years of age, there were no age differences in participation in organized sport, while participation in non-organized sport declined over this interval (Van Mechelen et al., 2000). The variation among studies probably reflects methodological differences. Sample representativeness is a concern in longitudinal studies.

What Are the Objectives of Youth Sports Programs?

Objectives of youth sport programs emphasize the enjoyment, well-being, fitness and health of participants. Stated objectives are ordinarily subsumed under several broad categories related to the development of (1) general and sport-specific movement skills; (2) physical fitness; (3) habits of regular physical activity; (4) social interactions with teammates, opponents and adults; (5) understanding of self; and (6) a sense of sportsmanship and fair play. More recently, youth sports are being heralded as a potentially important means to

combat the worldwide epidemic of childhood overweight and obesity through the provision of regular physical activity.

The identification and development of elite athletes has not been and is not an objective of most youth programs. However, some programs have as their objectives the identification and development of talented athletes. This is evident in talent identification programs in general; in sport-specific academies as in tennis and soccer; select teams as in basketball, soccer, baseball, softball, and so on; sport-specific clubs as in gymnastics, figure skating, tennis, and perhaps ballet; and special sport-specific summer camps and leagues in some countries. Although there is overlap among the examples listed, the emphasis is clear – preference for identification and development of talented young athletes.

Whether or not youth sports programs attain their objectives has not been systematically evaluated. Critical appraisal of potential benefits and risks associated with participation in youth sports provides a means of evaluating programs in general, recognizing, of course, that each program is unique.

Potential Benefits of Participation in Organized Sports

Skill Acquisition and Development

Improvement of motor skills in general and sport-specific skills is often a primary objective of youth sports programs ranging from those at the community level to more advanced sports schools and academies that ordinarily focus on a single sport. Improvement in sport skills is also a major motivation for children and adolescents to be involved in sport (Ewing and Seefeldt, 1989; see also Chapters 3 and 4, this volume). Given the importance placed upon skill acquisition, improvement and refinement in sport, it is somewhat surprising that the youth sport literature that deals with issues related to skill development of youngsters is not more extensive. In contrast, there is major focus on the development of expertise, often with talented and elite young athletes (Malina, 2008a; see also Chapter 9, this volume).

Improved Physical Fitness

Youth who are regularly active, including those in sport programs, tend to have higher levels of aerobic fitness compared to less active youth (Strong et al., 2005). Experimental aerobic and resistance training programs are associated with significant gains aerobic endurance and muscular strength and endurance, respectively (Strong et al., 2005; Malina, 2006a). Although these

data are not based on youth involved in specific sport programs, both aerobic and resistance training are often recommended for participants in many sports. Aerobic fitness is especially well developed in many adolescent athletes in sports with a high endurance component, e.g., distance running, swimming, cycling, soccer, ice hockey (Malina et al., 2004a). Issues related to the trainability of components of fitness are discussed in more detail in Chapters 9 and 10, this volume.

Physical Activity on a Regular Basis

Organized sport provides opportunity for physical activity on a regular basis and in a safe environment. Sports vary in intensity and continuity of activity. Team sports such as soccer, basketball, ice hockey and field hockey involve more or less reasonably continuous activity which varies in intensity during a match, while sports like baseball and American football involve intermittent activity among frequent periods of relative inactivity. Among individual sports, intermittent activity is characteristic of gymnastics, diving, racket sports and some field events in athletics, while continuous activity is a feature of swimming and running events in athletics.

The preceding are generalizations. Specific information on the activity status of youth involved and not involved in sport is somewhat limited. Among youth 12-14 years of age, evaluation of three day diary records indicated that boys and girls involved in organized youth sports expended, on average, more overall energy (total daily energy expended in absolute terms and per unit body mass) and energy in moderate-to-vigorous activities (≥ 4.8 METs) than non-participants (Katzmarzyk and Malina, 1998). Youth sports participants also indicated less television viewing time. Though limited to a single community in mid-Michigan which was surveyed in January and February (there may be variation by season of the year), the results suggest a greater level of physical activity and less time in one form of inactivity in participants compared to non-participants. In a more recent study which included accelerometry for a subsample of boys 6-12 years of age, participation in youth sport accounted for about one-fourth of 110 minutes of moderate-to-vigorous physical activity in the day (Wickel and Eisenmann, 2007). About one-half of time in youth sport was spent in sedentary and light-intensity activities (~52%), while time in moderate and vigorous activity was 27% and 22%, respectively. Time in moderate-to-vigorous physical activity on the day in which boys participated in sport was about 30 minutes greater than on the non-sport day, which highlights the potential contribution of participation in youth sport to daily physical activity.

Other data show similar trends. Although limited to questionnaire information, sport participants were also more physically active than non-

participants among rural South Carolina youth primarily 11-12 years (Trost et al., 1997), South Carolina girls about 13-18 years (Pfeiffer et al., 2006) and Finnish twins 16-18 years (Aarnio et al., 2002). Adolescent athletes 16-19 years of both sexes also had greater daily energy expenditure and energy expenditure in physical activity than non-athletes (Ribeyre et al., 2000).

Allowing for variation in the frequency, duration and intensity of physical activity associated with different sports, the important point is that youth involved in sport tend to me more physically active on a regular basis. And, regular physical activity, especially activity of moderate-to-vigorous intensity, is associated with health and fitness benefits (Strong et al., 2005). Several of the benefits – weight control, less adiposity, increased bone mineral content, improved aerobic capacity and muscular strength and endurance, and enhanced self-concept – are discussed subsequently.

Transfer to Adult Physical Activity

Although nor ordinarily indicated as an objective of youth sport programs, participation in sports during adolescence tends to track at higher levels than other indicators of physical activity (Malina, 2001). Tracking refers to the stability of a characteristic, in this case level of physical activity or participation in sport. Tracking is also related to prediction. Can adult physical activity be predicted from activity or sport participation during childhood and adolescence? Sport club membership (by inference, participation) tracks at a higher level than other indices of physical activity among Finnish adolescents and young adults (Telama et al., 1994, 1997). Further, the frequency of participation in sports at 14 years of age (Tammelin et al., 2003), membership in sport clubs at 16 years of age (Barnekow-Bergkvist et al., 2001) and sport club training and competition during adolescence (Telama et al., 2006) significantly predict physical activity in young adults of both sexes (late 20s-early 30s). The preceding observations are derived from Scandinavian countries. In the Michigan Study of Adolescent Life Transitions which sampled subjects at 12, 17 and 25 years of age, sport participation in childhood (time spent on sports) and adolescence (time in sports, kinds of after school activities) was a significant predictor of sport and physical fitness activities in young adulthood (Perkins et al., 2004).

Given the strong association between adolescent participation in sport and adult physical activity, more attention should be given to this context of physical activity among adolescents. An association between sport participation during adolescence and "psychological readiness" for physical activity in adulthood has been proposed (Engstrom, 1986, 1991) and highlights the need for study of the process through which participation in sport during adolescence translates into an active lifestyle in young adulthood. This issue is

especially relevant as many surveys indicate a decline in sports participation during adolescence (see above) and sport programs tend to become more selective. The results indicate a need to modify sport programs to accommodate youth with a wide range of skills. Many European countries have adopted such a focus as evident in a "sport for all" theme that contrasts interscholastic sport programs in the United States which become quite exclusive during adolescence. Sport offerings for youth with lesser skill or with less interest in elite competition are often limited in many communities in the United States.

Regulation of Body Weight and Composition

Regular physical activity associated with sport has the potential to favorably influence body weight and composition. Much of the focus, however, is on adiposity and there are more data for relatively elite young athletes in contrast to youth sport participants. Youth who are relatively high in physical activity tend to have less adiposity measured as skinfolds, percentage body fat and the BMI (Strong et al., 2005), whereas young athletes in a variety of sports, however, tend to have less adiposity (Malina et al., 2004). The contrast between athletes and non-athletes in percentage body fat is more apparent among females than males. There is variation among sports and some positions or disciplines within a sport, e.g., throwing events in track and field, linemen in American football (Malina, 2006b, 2007).

Youth Sports and the Prevention of Obesity

Organized sport is increasingly indicated as a potentially important context of physical activity to combat the epidemic of obesity among youth. In announcing the Youth Olympic Games: "The International Olympic Committee, *in an effort to fight childhood obesity and other problems associated with inactivity among children*, on Thursday voted to stage Youth Olympic Games modeled after the Olympics" (Michaelis, 2007, italics mine). It is not clear how an event modeled after the Olympics, i.e., for talented adolescent athletes, will combat obesity in the general population of youth throughout the world!

Two questions, perhaps among others, surface in this context. First, is the physical activity associated with youth sports of sufficient duration and intensity to prevent unhealthy weight gain (adiposity) in those of normal weight and thus prevent overweight and/or obesity, and to bring about a reduction in adiposity in those who are overweight and obese? Active youth and adolescent athletes have, on average, less relative fatness than the general population of youth. Experimental activity programs in normal weight youth appear to have a minimal effect on adiposity, while physical activity

interventions with overweight and obese youth result in reductions in overall adiposity and abdominal adiposity (Malina, in press). The beneficial effects of activity programs on fatness in obese youth are lost when the interventions are stopped. In other words, continued regular activity is essential although the amount of activity needed to maintain the benefits of interventions with obese youth is not known.

Second, are sports as presently constituted and practiced suitable for the obese? In other words, will obese youth have equal opportunities in sport compared to normal weight youth? Most youth sports as presently offered are not user friendly for the overweight and obese. American football, wrestling and weight events in track and field athletics are exceptions. These sports have a place for boys (and girls in track and field), who may be overweight and/or obese. However, given the value placed upon large size and mass per se, it is possible that these sports may place some participants at risk for persistent overweight or obesity.

A major issue is getting overweight and obese youth involved in sport programs. Limited movement capacity and proficiency may be major constraints. Excess body mass or fatness associated with obesity has a negative influence upon performances in motor and fitness tests which require movement or projection of the body. On the other hand, isometric and isokinetic strength are greater in obese compared to non-obese youth, reflecting the absolute size advantage of the obese. Limited proficiency in motor skills may limit access to or the experience of success in youth sports. Obese youth are often less proficient in motor skills and components of physical fitness which may reduce the likelihood of experiencing success in a sport (Malina et al., 2004a). If the objective of the Youth Olympics is to be attained, modification of sports programs to accommodate the special needs of overweight and obese youth is essential.

Improved Skeletal Health

Bone is a feature of body composition that is currently a focus of attention specifically in the context of preventing osteoporosis later in life. In general, the more mineral accumulated in the skeleton during growth and maturation, the better off the individual three or four decades later when mineral context of the skeleton begins to decline. And, regular physical activity has a beneficial effect on bone mineral content and bone mineral density. This is apparent in many studies of youth, including comparisons of athletes and non-athletes and retrospective studies of childhood and adolescent sport activity, relative to adult bone mineral content (Strong et al., 2005). Moreover, retrospective studies of athletes in racket sports highlight the beneficial effect of early onset of training on bone mineral content (Kannus et al., 1995).

Psychosocial Outcomes.

Social interactions with teammates, opponents and adults in and through sport experiences are generally assumed to benefit the psychosocial development of participants. Although there is considerable discussion of psychosocial outcomes associated with participation in youth sports, a good deal of the literature does not deal with outcomes per se. Much of the emphasis is on social influences – parents, coaches, peers – in contrast to the influence of sport on aspects of psychosocial development such as self-concept and self-esteem, perceived competence in sport and social interactions, peer interactions, parent-child and coach-child relationships, values of fair play, and so on. Sport-related issues dealing with parents and coaches are discussed in more detail in Chapters 6 and 7 (this volume).

Self-concept and its different domains is a behavioral outcome that has received most attention. Self-concept refers to the perception of self, whereas self-esteem refers to the value placed on one's self-concept. Self-concept comprises several domains—academic, social, emotional, physical, sport competence and appearance. The structure of self-concept changes with age and becomes more clearly differentiated in the transition into puberty and during adolescence. In cross-sectional studies, physical activity is positively correlated with global and physical self-concept, but weakly correlated social, emotional and academic self-concepts. Quasi-experimental studies indicate strong positive effects of physical activity on global self-concept and specific domains of physical self-concept, appearance and sport competence; on the other hand, effects on the social and academic domains of self-concept are rather weak (Strong et al., 2005). Although sport activities are positively associated with global self-concept and perceived sport competence, they also have the potential for negative influences. Two key factors in this context are outcome (i.e., winning or losing) and quality of adult involvement, specifically coaches per se and coaching styles (Smoll and Smith, 2003).

Identifying other psychosocial outcomes associated with participation in youth, sports, and of course measuring them, is more challenging. A good deal of the research has focused on potential influences of adults – coaches and parents – in contrast to the potential influence of sport per se on behavioral development. Less research has focused on peers as important agents in psychosocial outcomes associated with sport. This may be expected given the degree of adult involvement in youth sports and the quality of adult-youth interactions in the context of sport. Research on parents has focused on expectations and pressures, perceptions of competence, goal orientation, responses to performances of their child, degree of involvement, role

modelling, and son on (Brustad, 2003; Weiss, 2003). Research on coaches has focused on the coach as a source of information about sport competence, the frequency and types of feedback to young athletes and the effects of coach education on the quality of youth sport experiences (Weiss, 2003; Smoll and Smith, 2003). An additional concern, specifically in North America, is the dual role of the parent-coach. The earliest sport experiences of many youth occur under the guidance of parent-coaches.

Coaches who are supportive and who emphasize learning and improvement (a mastery-oriented climate) facilitate beneficial psychosocial outcomes, e.g., perceptions of competence, sport enjoyment, positive friendships, and so on. Similar outcomes are associated with coaches who undergo a coach effectiveness training program (Smoll and Smith, 2003). Issues related to coaches are discussed in more detail in Chapter 5 (this volume) and Chapter 27 (Volume 2).

Much remains to be done to better understand and specific psychosocial outcomes associated with sport participation among children and adolescents. The complex interactions among young athletes, parents, coaches and peers in the context of a sport highlight the need for creative methodology to better understand the processes, interactions and potential outcomes.

Moral/Ethical Behaviors.

Participation in sport can be a vehicle for moral or ethical development. This is generally subsumed in the generic terms sportsmanship, fair play, being a "good sport" and character development, among others. Progress toward the development of morally competent behaviors includes the ability to recognize right from wrong, abiding by the rules of the game during practices and competitions, and respect for teammates and opponents. However, the potential influence of sport participation on the development of moral reasoning needs to be established (Bredemeier, 2003; Bredemeier and Shields, 2006).

Much remains to be done in understanding the contributions of participation in youth sports to moral or ethical development. A recent survey of 5th to 8th grade sport participants (~10-14 years) noted that 9% acknowledged cheating, 13% reported attempts to injure an opponent, 27% noted behaviors associated with being a "bad sport", and 31% reported arguing with game officials. Of interest, 7% of youth reported encouragement from their coaches to cheat, while 8% reported encouragement to injure an opponent (Shields et al., 2005). The use of prohibited performance enhancing substances by young athletes is a related issue. Though apparently not

widespread, a small but significant percentage of youth, athletes and non-athletes, have tried or have been enticed into using these substances (Faigenbaum et al., 1998; Laure and Binsinger, 2005). Of interest, parents, friends and even family physicians are indicated by the adolescents as the source of the performance enhancers (Laure and Binsinger, 2005).

Presently available evidence highlights the central role of coach behaviors, specifically deliberate attempts to teach ethical/moral values (Bredemeier and Shields, 2006). The role of the media and the high level sports culture also needs careful consideration in this context as what happens at higher levels often trickles down to lower levels. One wonders what message is sent to youth by "professional fouls" in soccer or the fact that virtually every foul towards the end of a basketball game is deliberate and at times flagrant. A college basketball broadcaster offered the following observation: "Intelligent fouling is a good strategy" (University of Illinois vs Michigan State University, 1 March 2009). This comment essentially translates as follows: deliberate violation of game rules is a good strategy! The line that separates strategy and cheating to gain an advantage in sport is indeed fine and becoming finer!

Other Social Outcomes

Other benefits have been attributed to sport participation, especially interscholastic sport, though the evidence is variable in quality. These include greater likelihood of staying in school and fewer absences from school (Marsh, 1993), reduced likelihood of being involved in delinquent behavior (Segrave and Hastad, 1982), and fewer risk-taking sexual behaviors and pregnancies (Sabo et al., 1998; Savage and Holcomb, 1999). Sport participation among youth is associated with a reduction in suicide ideation and suicide attempts (Oler et al., 1994; Women's Sports Foundation, 2000; Sabo et al., 2005; Brown et al., 2007). These associations, though interesting, need to be more critically evaluated in the context of the many factors known to influence adolescent behaviors.

Potential Risks of Participation in Organized Sports

Risk of Injury.

Children and adolescents incur injury in organized and unorganized sport, in addition to many other activities. Injuries can be classified as acute – fractures, sprains, strains, general trauma, and overuse – microtrauma associated with excessive repetition of specific sport activities. The latter are receiving considerably more attention given their increasing prevalence among youth

and organized youth sports are often indicated as the primary cause of overuse injuries. Issues related to definition, surveillance, epidemiology and risk factors for injury in youth sports are discussed in more detail in Chapters 13 and 14 (this volume).

Competitive Stress.

Discussions of potential psychological or behavioral risks associated with sport for children and adolescents are often set in the context of competitive stress. In fact, there has been concern for stress in organized youth sports since their inception. Stress is a physiological state and as such is beset with problems of measurement – physiological measures per se (heart rate, galvanic skin response, hormonal levels) and lack of correlation between paper and pencil scales commonly used in surveys of youth sport participants. A major factor is individual differences in the perception or lack of perception of stress.

Sport-related stress is generally transient depending on the flow of games or competitions. Stress is more accentuated in individual sports in which athletes compete or perform as individuals, e.g., gymnastics, figures skating, diving, swimming and distance running. Performance evaluations per se tend to be stressful, especially in the aesthetic sports; seemingly subjective judgments of adults evaluating the performances undoubtedly contribute to the stress. On the other hand, the greater number of athletes involved and the highly interactive nature of activities in team sports tend to diffuse responsibility so that the performance of any individual athlete is generally less conspicuous and performance evaluation is less of a threat. The buffer of team members may alleviate stress associated with mistakes and losing. There are, of course, situational exceptions such as the penalty shot in soccer and free throws in basketball. In contrast to actual competitions, it is more difficult to gauge stress in the training or practice environments of specific sports which are ordinarily under the control of coaches, each with their own style of teaching and training.

Potential consequences of competitive stress include lowered self-esteem, elevated anxiety, more aggressive behavior, injury, "burnout" (see below) and perhaps others. Factors associated with stress include failure; negative performance evaluations by coaches, parents and peers; and unrealistic expectations by self, parents and coaches.

The influence of interactions between biological and behavioral characteristics of young athletes in contributing to stress and potentially negative outcomes associated with sport has not received attention in the context of youth sport. The transition into puberty as well as sexual maturation per se and the adolescent growth spurt include major physical,

physiological and behavioral alterations. Puberty is often described as a period of physiological learning as youth adapt to the changes taking place in their bodies. Of relevance to sport, these changes often occur at a time when there is considerable emphasis on sport selection and specialization. Evidence of biobehavioral interactions associated with sport is apparent in social physique anxiety and disordered eating, especially among girls.

Attrition

Attrition or dropping-out is often indicated as a potential negative outcome of youth sports. It is often discussed in the context of the age-associated decline in sport participation and physical activity in general which is evident in many, though not all, studies (Malina, 2008b).

The concept of drop-out as a risk of participation in organized sport has a problem with definition. Does it refer to complete cessation of participation in a sport or physical activity? Does it include youth who leave one sport only to begin participation in another sport or in non-sport activities? Behavioral change associated with puberty and adolescence is a potential confounder. Changing interests (sport and non-sport) and changing and often conflicting demands of home, school, sport and social activities commonly occur. This is normal development!

Factors associated with cessation of participation include reasons not related to and related to sport. The former include loss of interest and lack of enjoyment in the sport, interest in non-sport activities, time requirements, time for study, and costs. Sport-related factors include lack of playing time, lack of success, limited progress in development of sport skills, lack of enjoyment, coach behaviors (favoritism, teaching style), poor training environment, unrealistic expectations, emphasis on competition and winning, and injury, among others. These are included among motives for discontinuing participation in sport among American (Ewing and Seefeldt, 1988) and Mexican (Chapter 3, this volume) youth. A relevant question that needs consideration is the following: How can sport be modified to meet the interests of youth and permit broader participation, especially during adolescence?

As youth pass from childhood into adolescence, many sports become more selective. Issues related to selection versus exclusion also need to be considered. Does "cutting" by a coach or sport program represent premature drop-out?

In many sports for boys, there appears to be discrimination by maturity level. For example, among youth soccer and ice hockey players, a

broad range of skeletal maturity is represented among younger participants 10-12 years of age, i.e., boys with both late and advanced skeletal ages are almost equally represented. However, among players 13-16 years of age, late maturing boys (skeletal age behind chronological age by more than one year) are less often represented (Malina, 2003; see also Chapters 16 and 18, Volume 2). Thus, with advancing chronological age and presumably experience, boys advanced in biological maturity are more common among adolescent players in soccer and ice hockey. This may reflect selection or exclusion (self, coach, sport system, or some combination), differential success of boys advanced in maturity, the changing nature of the games (more physical contact may be permitted in older age groups with an advantage for larger, stronger, more mature boys), or some combination of these factors. On the other hand, later maturing boys are often successful in some sports in later adolescence (16-18 years), e.g., track, basketball. This is associated with the catch-up in biological maturity and late adolescent growth, i.e., all youth eventually reach maturity, and with the reduced significance of maturity-associated differences in body size and performance of boys in late adolescence.

Later maturation, on the other hand, tends to me more common among successful young female athletes. Examination of the distributions of adolescent athletes by age at menarche shows a predominance of average (on time) and later maturing girls and a limited number of early maturing girls. The distributions may reflect selection practices in specific sports, e.g., small body size in gymnastics and figure skating, linear physique among distance runners, and so on; and differential sport success of girls late in maturation. Additional factors may relate to changes in proportions (relatively broad hips and shorter legs) and body composition (increased absolute and relative fatness) associated with sexual maturation in girls (Malina et al., 2004). The potential role of behavioral factors associated with variation in maturity timing and sport participation among girls needs study.

Burnout

Burnout is a concept that is commonly used in the context of high performance sports in both youth and adults. It refers to withdrawal from sport due to chronic stress. It is emphasized that burnout is not equivalent with drop out as discussed above. Burnout is sometimes described as "burning desire". It is not sudden in onset; rather, it develops over time and is frequently associated with perceptions by the young athlete that he/she cannot meet the physical and/or psychological demands placed upon him/her. Reduction in accomplishment in sport and associated rewards (i.e., no longer receiving them) are additional factors. Signs of chronic stress include behavioral alterations such as agitation, sleep disturbances, and loss of interest

in practice. Other manifestations include depression, lack of energy, skin rashes and nausea, and frequent illness (Weinberg and Gould, 1995; Gould and Dieffenbach, 2003).

Many factors are involved in the development of burnout. Three especially important factors are negative performance evaluations, which are usually critical rather than supportive; inconsistent feedback from coaches and officials, which often translates into mixed messages for the young athlete; and overtraining. A contributing factor is overprotection by coaches, trainers, parents and sport officials, which limits exposure of young athletes to new situations and thus opportunities to develop coping mechanisms and social relationships. Overprotection may foster feelings of lack of control, dependency and a sense of being powerless. Self- perceptions of not being able to meet expectations imposed by self and/or others are additional factors (Gould and Dieffenbach, 2003). Injury is often a contributing factor to burnout as the individual may not be able to perform in the sport that is important to him/her. It should be noted that sport-related conditions conducive to the development of burnout in youth are superimposed on and interact with the normal biological and behavioral demands of adolescence.

Compromised Growth and Maturation

Discussions of the merits of youth sport often include a caveat regarding potentially negative influences of training for sport on growth (size attained) and maturation (timing and tempo of progress to the mature state). Historically, sport training has been viewed as having a stimulatory or accelerating influence on the processes of growth and maturation. Given the expansion of youth sports specifically in the context of year-round training, increased training demands and national and international competitions, it is periodically suggested that systematic training for some sports may have potentially negative influences on growth and maturation. Concern is expressed more often for elite young athletes, especially girls. Although compromised growth and maturation as a result of intensive sport training during childhood and adolescence is often suggested in the clinical and popular literature, presently available data are do not support the assertions (Malina et al., 2004; see also Chapter 8, this volume).

Are Programs for the Talented a Risk?

The media often highlight the accomplishments of adolescent athletes in many sports. We have just come off an Olympic year (Beijing 2008) and young athletes for better or worse were the darlings of the media. What the media and Olympic Games highlight, however, are the extremely small number who make it through rigorous identification and development programs. Those

who do not make it through these rigors are rarely, if ever, mentioned. It is legitimate, therefore, to inquire if being labeled as "talented" in a sport at a relatively young age is a risk?

Being labeled as talented encourages early specialization and year-round training and participation in a single sport. A consequence is limited experiences with other sports and activities, which some involved in talent development would call "multilateral training". In many cases, year-round training in a single sport at a relatively young age often involves major compromises by and stresses on families. It is legitimate to inquire whether the youngster has a voice in the decision making. Likewise, what is the implication of being labeled talented on parental expectations? Some parents make take this as a cue to "market" their child!

Elite young athletes face potential risks in the social, nutritional, chemical and commercial domains. Social manipulation is perhaps most evident in preferential treatment of talented athletes by the respective sport systems, the media and perhaps schools. It is also evident in differential access to resources that favor the elite as in travel, tutors for school work, access to scholarships and others. On the other hand, the preferential treatment may lead to over-dependence on and/or control by coaches and sport organizations, and altered social relationships with peers, parents and family. A potential byproduct of excessive dependence of young athletes upon coaches and sport officials (and often blind faith and trust of parents) is potential for emotional abuse – verbal or non-verbal, physical abuse and sexual abuse and molestation. There is a need for vigilance and systematic monitoring and study of coaching/training environments in select/elite youth sport programs. Stresses associated with year round training and competitions are byproducts of these environments. A study of young female athletes noted that 3 of 27 highly trained gymnasts and 4 of 16 moderately trained swimmers were considered at risk for "a manifest mental disorder over time" (Theintz et al., 1994). Although the majority of athletes did not present problems, the need monitor the coaching/training environment is obvious.

Another form of social manipulation is age modification. Competition by age group is a feature of virtually all youth sports. The integrity of age-group competitions is based upon the assumption that reported ages are accurate and records of age (birth certificates, passports) are valid. Nevertheless, problems with accurate age reporting appear on a regular basis in youth sports (Malina, 2005) and with elite young athletes (Macur, 2008; Hogg, 2009). What is the source of inaccurate reporting or age falsification? It probably lies in the culture of sport with its emphasis on winning at all costs. And, who regulates sport, specifically youth in sport? Clearly, administrators,

trainers, coaches and others associated with sport including parents need scrutiny.

Dietary manipulation, both direct and indirect, is a concern in some sports. Some adolescents may institute self-imposed dietary restriction, especially in aesthetic sports such as artistic gymnastics, figure skating and ballet. Pressures, at times subtle, to maintain or lose weight by young athletes, especially in aesthetic sports and wrestling, when the natural course of growth is to gain weight, can lead to disordered eating and clinical eating disorders. At times, direct and indirect comments on body weight from trainers and coaches may serve as a trigger to disordered eating. On the other hand, dietary restrictions on elite young athletes come directly from sport governing bodies. In the former German Democratic Republic (DDR), for example, gymnasts were on a dietary regime "…intended to maintain the optimal body weight, i.e., a slightly negative energy balance, and thus a limited energy depot over a long period" (Jahreis et al., 1991, p. 98). Such intentional energy deficit is an abuse.

Chemical manipulation is seemingly rampant in sport. It can take several forms including dietary supplements (e.g, creatine, "fat burners" with caffeine as a major ingredient), diuretics to lose weight, stimulants, and of course performance enhancing drugs). The use of prohibited performance enhancing substances by young athletes is an issue. Though apparently not widespread, a small but significant percentage of youth, athletes and non-athletes, have tried or have been enticed into using these substances (Faigenbaum et al., 1998; Laure and Binsinger, 2005). Of interest, parents, friends and even family physicians are indicated by the adolescents as the source of the performance enhancers (Laure and Binsinger, 2005). Another form of chemical manipulation that may be on the horizon is "gene doping," an extension of gene therapy, in which genes with potential to improve performance are implanted into the cells of an athlete (Haisma and de Hon, 2006).

Sport merchandising is commonplace today. What is overlooked is the fact that young athletes are often the merchandise! This is commercial manipulation. Talented young athletes in many sports, in many cases under-age, are being regularly sought and are often exploited. Corporate money permeates developmental programs for young tennis players, e.g., the International Management Group tennis academy. Soccer, baseball, basketball and American football players are widely scouted and actively pursued at young ages. Many athletes are from lower socioeconomic backgrounds so that there is potential for exploitation of both the youngster and family. Sport, on one hand, is often placed ahead of education and on the other hand is the lure for promise of education (scholarships). Many clubs develop young

players for the international market (soccer in Africa and South America, baseball in the Caribbean) and jobs may be offered to families of talented youth to bypass official regulations. There is even discussion of international legislation to regulate sport agents and clubs, especially those pursuing under-age players (BBC News, 2007). Youth basketball coaches for select adolescent teams are often labeled as brokers as they often control access to college coaches. American high schools are, to some extent, a publicly subsidized (i.e., local school taxes) farm system for collegiate and professional basketball and American football and to a lesser extent baseball. Select soccer programs have a similar role in developmental tracks for professional soccer in the U.S. and national teams. Moreover, some high schools require minimal academic study, "diploma mills" (Thamel and Wilson, 2005) or focus only on basketball, fostering a "…culture of free agency" among youth players (Thamel, 2006).

Overview

Involvement in organized sport is a feature of the daily lives of children and adolescents the world over. Participation in sport has the potential for positive and negative experiences and outcomes in youth. The line between potential benefits and risks may be quite fine. In many instances, increased risks are associated with adult behaviors and expectations and the systems for specific sports. Nevertheless, benefits outweigh the risks and participation in sports is a satisfying experience for most children and adolescents. Experience in sport, of course, is not a single point in time; rather, it is a continuum running from enjoyment to burnout that spans many years and that has many shades or degrees between the extremes.

The charge of those who work with youth sports – coaches, trainers, teachers, administrators, parents and also the media – is to provide an environment that is conducive to maximizing potential benefits and minimizing potential risks for the youth involved. Sport is only one part, albeit an important one, of the experience of "growing up" which places many demands on youth. Like all youth, young athletes also have the need to be a child or adolescent. They are neither miniature adults nor commodities!

References

Aarnio M, Winter T, Peltonen J, Kujala UM, Kaprio J (2002) Stability of leisure-time physical activity during adolescence-a longitudinal study among 16-, 17- and 18-year-old Finnish youth. *Scandinavian Journal of Medicine and Science in Sports* 12:179-185.

Australian Bureau of Statistics (2003) Yearbook of Australia, Culture and Recreation: Children's Participation in Sports and Leisure Activities, www.abs.gov.au, accessed 2 May 2003.

Barnekow-Bergkvist M, Hedberg G, Janlert U, Jansson E (2001) Adolescent determinants of cardiovascular risk factors in adult men and women. *Scandinavian Journal of Public Health* 29:208-217.

BBC News (2007) EU signals bigger role in sport. (www.bbcnews.com, accessed 11 July).

Bredemeier BL (2003) Moral community and youth sport in the new millennium. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA; Coaches Choice, pp 171-182.

Bredemeier BL, Shields DL (2006) Sports and character development. *President's Council on Physical Fitness and Sports*, series 7, no 1.

Brown DR, Galuska DA, Zhang J, Eaton DK, Fulton JE, et al. (2007) Physical activity, sport participation, and suicidal behavior:U.S. high school students. *Medicine and Science in Sports and Exercise* 39:2248-2257.

Brustad RJ (2003) Parental roles and involvement in youth sport: Psychosocial outcomes for children. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA; Coaches Choice, pp 127-138.

Engstrom LM (1986) The process of socialization into keep fit activities. *Journal of Sports Science* 8:89-97.

Engstrom LM (1991) Exercise adherence in sport for all from youth to adulthood. In P Oja, R Telama (eds): *Sport for All*. Amsterdam: Elsevier Press, pp 473-483.

Ewing ME, Seefeldt V (1989) American youth and sports participation. North Palm Beach, FL: American Footwear Association.

Faigenbaum AD, Zaichkowsky LD, Gardner DE, Micheli LJ (1998) Anabolic steroid use by male and female middle school students. *Pediatrics* 101 (5):e1-e6.

Farrey T (2008) *Game On: The All-American Race to Make Champions of Our Children*. New York: ESPN Books.

Gould D, Dieffenbach K (2003) Psychological issues in youth sports: competitive anxiety, overtraining, and burnout. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA; Coaches Choice, pp 149-170.

Haisma HJ, de Hon O (2006) Gene doping. *International Journal of Sports Medicine* 27:257-266.

Heinemann K (1999) Sport clubs in Europe. In K Heinemann (Ed), *Sport Clubs in Various European Countries*. Schorndorf, Germany: Karl Hofmann, pp 13-32.

Hogg C (2009) China athletes 'faked their age." BBC News 16 March 2009 (www.news.bbc.co.uk accessed 16 March 2009).

Istituto Nazionale di Statistica (2005) Lo sport che cambia: I comportamenti emergenti e le nuove tendenze della pratica sportiva in Italia. Roma: Istituto Nazionale di Statistica.

Jahreis G, Kauf E, Frohner G, Schmidt HE (1991) Influence of intensive exercise on insulin-like growth factor I, thyroid and steroid hormones in female gymnasts. *Growth Regulation* 1:95-99.

Kannus P, Haapasalo H, Sankelo M, Sievanen H, Pasanen M, Heinonen A, Oja P, Vuori I (1995) Effect of starting age of physical activity on bone mass in the dominant arm of tennis and squash players. *Annals of Internal Medicine* 123:27-31.

Katzmarzyk PT, Malina RM (1998) Contributions of organized sports participation to estimated daily energy expenditure in youth. *Pediatric Exercise Science* 10:378-386.

Laure P, Binsinger C (2005) Adolescent athletes and the demand and supply of drugs to improve their performance. *Journal of Sports Science and Medicine* 4:272-277.

Macur J (2008) A visit to the athletes' village to see the (perhaps underage) Chinese gymnasts. New York Times 3 August (www.nytimes.com accessed 12 August 2008).

Malina RM (2001) Tracking of physical activity across the lifespan. *Research Digest: President's council on Physical Fitness and Sports*, series 3, no 14.

Malina RM (2003) Growth and maturity status of young soccer (football) players. In T Reilly, M Williams (Eds), *Science and Soccer*, 2nd edition. London: Routledge, pp 287-306.

Malina RM (2005) Estimating passport age from bone age: Fallacy. *Insight, The FA Coaches Association Journal*, autumn/winter, pp 23-27.

Malina RM (2006a) Weight training in youth-growth, maturation, and safety: an evidence-based review. *Clinical Journal of Sports Medicine* 16:478-487.

Malina RM (2006b) *Growth and Maturation of Child and Adolescent Track and Field Athletes / Crescita e Maturazione di Bambini ed Adolescenti Praticanti Atletica Leggera*. Rome, Italy: Centro Studi e Ricerche, Federazione Italiana di Atletica Leggera.

Malina RM (2007) Body composition in athletes: Assessment and estimated fatness. *Clinics in Sports Medicine* 26:37-68.

Malina RM (2008a) Skill: Acquisition and Trainability. In O Bar-Or and H Hebestreit (Eds), *The Young Athlete*. Oxford, UK: Blackwell Publications, pp 96-111.

Malina RM (2008b) Biocultural factors in developing physical activity levels. In AL Smith, SJH Biddle (Eds), *Youth Physical Activity and Inactivity: Challenges and Solutions*. Champaign, IL: Human Kinetics, pp 141-166.

Malina RM (in press) Childhood and adolescent physical activity and risk of adult obesity. In C Bouchard, PT Katzmarzyk (Eds), *Advances in Physical Activity and Obesity*. Champaign, IL: Human Kinetics.

Malina RM, Bouchard C, Bar-Or O (2004) *Growth, Maturation, and Physical Activity*, 2nd edition. Champaign, IL: Human Kinetics.
Marsh HW (1993) The effects of participation in sport during the last two years of high school. *Sociology of Sport Journal* 10:18-43.
Michaelis V (2007) IOC votes to start Youth Olympics in 2010. USA Today 5 July, http://www.usatoday.com/sports/olympics/2007-07-05-youth-notes_N.htm, accessed 7 January 2008).
National Council of Youth Sports (2001) Report on Trends and Participation in Organized Youth Sports. Stuart, FL: National Council of Youth Sports, www.ncys.org.
National Council of Youth Sports (2008) Report on Trends and Participation in Organized Youth Sports. Stuart, FL: National Council of Youth Sports, www.ncys.org.
National Federation of State High School Associations (2006) 2005-2006 high school athletics participation survey (www.nfhs.org accessed 23 September 2006)
Oler MJ, Mainous AG, Martin CA, Richardson E, Haney A, Wilson D, Adams T (1994) Depression, suicidal ideation, and substance abuse among adolescents. Are athletes at less risk? *Archives of Family Medicine* 3:781-785.
Pennington B (2005) Doctors see a big rise in injuries for young athletes. New York Times 22 February (www.nytimes.com accessed 22 February 2005).
Perkins DF, Jacobs JE, Barber BL, Eccles JS (2004) Childhood and adolescent sports participation as predictors of participation in sports and physical fitness activities during young adulthood. *Youth and Society* 35:495-520.
Pfeiffer KA, Dowda M, Dishman RK, McIver KL, Sirard JR, Ward DS, Pate RR (2006) Sport participation and physical activity in adolescent females across a four year period. *Journal of Adolescent Health* 39:523-529.
Ribeyre J, Fellmann N, Montaurier C, Delaitre M, Vernet J, Coudert J, Vermorel M (2000) Daily energy expenditure and its main components as measured by whole-body indirect calorimetry in athletic and non-athletic adolescents. *British Journal of Nutrition* 83:355-362,
Sabo D, Miler K, Farrell M, Barnes G, Melnick M (1998) *The Women's Sports Foundation Report: Sport and Teen Pregnancy*. East Meadows, NY: Women's Sports Foundation.
Sabo D, Miller KE, Melnick MJ, Farrell MP, Barnes GM (2005) High school athletic participation and adolescent suicide. *International Review for the Sociology of Sport* 40:5-23.
Savage MP, Holcomb DR (1999) Adolescent female athlete's sexual risk-taking behaviors. *Journal of Youth and Adolescence* 28:595-602.
Seabra A, Mendonca D, Thomis M, Malina RM, Maia J (2007) Levels of sports participation among Portuguese youth 10-18 years. *Journal of Physical Activity and Health* 4:370-380.
Segrave JO, Hastad DN (1982) Delinquent behavior and interscholastic athletic participation. *Journal of Sport Behavior* 5:96-111.

Shields D, Bredemeir BL, LaVoi N, Power FC (2005) The sport behavior of youth, parents, and coaches: The good, the bad, and the ugly. *Journal of Research in Character Education* 3:43-59.

Smoll FL, Smith RE (2003) Enhancing coaching effectiveness in youth sports: theory, research, and intervention. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA; Coaches Choice, pp 227-239.

Sport England (2003) Young People and Sport. National Survey 2002, www.sportengland.org/young-people-and-sport-2002 (accessed 3 June 2004).

Sporting Goods Manufacturers Association (2001) U.S. Trends in Team Sports, 2001 edition. North Palm Beach, FL: Sporting Goods Manufacturers Association.

Stotz CE, Baldwin MW (1952) *At Bat with the Little League*. Philadelphia: Macrae Smith Company.

Strong WB, Malina RM, Blimkie CJR, Daniels SR, Dishman RK, Gutin B, Hergenroeder AC, Must A, Nixon PA, Pivarnik JM, Rowland T, Trost S, Trudeau F (2005) Evidence based physical activity for school youth. *Journal of Pediatrics* 146:732-737.

Tammelin T, Nayha S, Hills AP, Jarvelin M-R (2003) Adolescent participation in sports and adult physical activity. *American Journal of Preventive Medicine* 24:22-28.

Telama R, Laakso L, Yang X (1994) Physical activity and participation in sports of young people in Finland. *Scandinavian Journal of Medicine and Science in Sports* 4:65-74.

Telama R, Laakso L, Yang X, Vikari J (1997) Physical activity in childhood and adolescents as predictor of physical activity in young adulthood. *American Journal of Preventive Medicine* 13: 317-323.

Telama R, Yang X (2000) Decline of physical activity from youth to young adulthood in Finland. *Medicine and Science in Sports and Exercise* 32:1617-1622.

Telama R, Yang X, Hirvensalo M, Raitakari O (2006) Participation in organized youth sport as a predictor of adult physical activity: A 21-year longitudinal study. *Pediatric Exercise Science* 17:76-88.

Thamel P (2006) Schools where the only real test is basketball. New York Times 25 February (www.nytimes.com, accessed 25 February).

Thamel P, Wilson D (2005) Poor grades aside, athletes get into college on a $399 diploma. New York Times 27 November (www.nytimes.com, accessed 3 December).

Theintz G, Ladame F, Kehre E, Plichta C, Howald H, Sizonenko PC (1994) Prospective study of psychological development of adolescent female athletes: initial assessment. *Journal of Adolescent Health* 15:258-262.

Trost SG, Pate RR, Saunders RP, Ward DS, Dowda M, Felton G (1997) A prospective study of the determinants of physical activity in rural fifth-grade children. *Preventive Medicine* 26:257-263.

Van Mechelen W, Twisk JWR, Post GB, Kemper HCG (2000) Physical activity of young people: The Amsterdam Longitudinal Growth and Health Study. *Medicine and Science in Sports and Exercise* 32:1610-1616.

Weinberg RS, Gould D (1995) *Foundations of Sport and Exercise Psychology*. Champaign, IL: Human Kinetics.

Weiss MR (2003) Social influences on children's psychosocial development in youth sports. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA; Coaches Choice, pp 109-126.

Wickel EE, Eisenmann JC (2007) Contribution of youth sport to total daily physical activity among 6- to 12-yr-old boys. *Medicine and Science in Sports and Exercise* 39:1493-1500.

Women's Sports Foundation (2000) *Health Risks and the Teen Athlete. East Meadow*, NY: Women's Sports Foundation.

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CHAPTER 2: YOUNG BODIES IN SPORT - ascetic "hard work" and new wave "just do it"

Rui A Gomes

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.).

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.

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.

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.

REFERENCES

Blaxter M (1993) Why do the victims blame themselves. In A Radley (Ed): *Worlds of Ilness: Biographical and Cultural Perspectives on Health and Disease*. London: Routledge, pp. 125-145.

Bordo S (1993) *Unbearable Weight*. Berkeley: University of California Press.

Crawford R (1980) Healthism and the medicalization of everyday life. *International Journal of Health Services* 10: 365-388.

Gilman SL (1988) *Disease and Representation: Images of Illness from Madness to AIDS*. Ithaca: Cornell University Press.
Gilman SL (1995) *Health and Illness: Images of Difference*. London: Reaction Books.
Foucault M (1988) Technologies of the Self. In L H Martin, H Gutman, and P H Hutton (Eds): *Technologies of the Self*. London: Tavistock, pp. 16-49.
Gomes R (2002) *Tempos, Espaços e Consumos de Lazer Desportivo dos Estudantes Universitários de Coimbra*. Coimbra: FCDEFUC/PAFID.
Marzano-Parisoli MM (2001) The contemporary construction of a perfect body image: Bodybuilding, exercise addiction, and eating disorders. *Quest* 53: 216-230.
Mauss M (1973) Techniques of the body. *Economy and Society* 2(1): 70-88.
Mauss M (1979) The category of the person. In M Mauss (Ed): *Psychology and Sociology: Essays*. London: Routledge and Kegan Paul, pp. 57-94.
O'Malley P (1992) Risk, power and crime prevention. *Economy and Society* 21: 252-275.
Shepard RJ (1995) Physical activity, fitness, and health: The current consensus. *Quest* 47: 288-303.
Shilling C (1993) *The Body and Social Theory*. London: Sage.

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CHAPTER 3: PARTICIPATION IN ORGANIZED SPORT AMONG URBAN MEXICAN YOUTH

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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.

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. Another 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 third questionnaire related to reasons for returning to sport participation was 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…".

RESULTS

a) 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	N	%	Girls	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.

b) 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.

c) 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.

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

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.

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 ($p \leq 0.05$).

d) Motives for Discontinuing Sport

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

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.

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.

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

e) 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.

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).

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, 2002).

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 (present study)	American Boys (Adapted from Ewing and Seefeldt, 1988).
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

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 (present study)	American Girls (Adapted from Ewing and Seefeldt, 1988).
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

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 (present study)		American Boys (Adapted from Ewing and Seefeldt, 1988)
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

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.

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.

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 (present study)		American Girls (Adapted from Ewing and Seefeldt, 1988)	
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

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).

REFERENCES

DeKnop P, Engstrom LM, Skirstad B, Weiss MR (1996) *Worldwide Trends in Youth Sport*. Champaign, IL: Human Kinetics.

Engstrom LM (1986) The process of socialization into keep fit activities. *Journal of Sports Science*. 8: 89-97.

Engstrom LM (1991) Exercise adherence in sport for all from youth to adulthood. In P Oja, R Telama (eds): *Sport for All*. Amsterdam: Elsevier Press. pp 473-483.

Ewing ME, Seefeldt V (1988) *Participation and attrition patterns in American agency-sponsored and interscholastic sports: An executive summary*. East Lansing: Michigan State University. Institute for the Study of Youth Sports.

Katzmarzyk PT, Malina RM (1998) Contributions of organized sports participation to estimated daily energy expenditure in youth. *Pediatric Exercise Science* 10:378-386.

Kuh DJL, Cooper C (1992) Physical activity at 36 years: Patterns and childhood predictors in a longitudinal study. *Journal of Epidemiology and Community Health* 46:114-119.

Malina RM (1995) Physical activity and fitness of children and youth: Questions and implications. *Medicine Exercise Nutrition and Health.* 4:123-135.

Malina RM (2001) Tracking of physical activity across the lifespan. P*resident's Council on Physical Fitness and Sports Research Digest*. Series 3. No. 14 (September).

Malina RM (2002) Sports. school. In JW Guthrie (ed): *The Encyclopedia of Education*. 2nd edition. New York: Macmillan Reference USA, pp 2305-2312.

Sporting Goods Manufacturers Association (2001) *U.S. Trends in Team Sports: 2001 Edition*. North Palm Beach, FL: Sporting Goods Manufacturers Association.

Taylor WC, Blair SN, Cummings SS, Wun CC, Malina RM (1999) Childhood and adolescent physical activity patterns and adult physical activity. *Medicine and Science in Sports and Exercise* 31:118-123.

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CHAPTER 4: MOTIVATION FOR SPORT IN PORTUGUESE YOUTH - biological and social dimensions

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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;
- Potential association of somatic variables and social stimuli for sport with motives for participation in sports.

METHODS

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

Motivation for sport was assessed with the 30-item questionnaire of Gill *et al*. (1983). The questionnaire was designed to include possible reasons for participating in organized sports programs. 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, sitting height/stature ratio, index of androgyny, 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.

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. The technique 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).

RESULTS

a) Sport participation

Among boys, 31% indicated no history of participation in organized sport, while 31% were formally involved in organized sport but not involved at the time of the survey, and 38% were currently involved in organized sport. Corresponding data for girls indicated a major sex difference. The majority of girls, 57% indicated no history of participation in organized sport and 34% were formally involved in organized sport. Only 9% of the girls 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 was the most popular individual sport in both sexes.

b) Motives for participating in sports

Results of the factor analysis of the motivation for sport questionnaire in the total sample are summarized in Table 1. 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).

Table 1. 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

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."

c) Sex differences in motives for participating in sports

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 2. Boys have, on average, higher scores on three of the factors: F1, Achievement Status ($p<0.01$); F2, Sport Goals ($p<0.01$); and F6, Social Influence ($p<0.05$). Girls have, on average, a higher score on F5, Fun ($p<0.01$). 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 3. 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 2. Comparisons of means between males and females on participation motivation factors.

Factor	Males (n=387)	Females (n=410)	t	p
Achievement status (AS)	2.53 ± 0.77	2.21 ± 0.69	6.18**	.00
Sport goals (SG)	3.98 ± 0.69	3.70 ± 0.65	1.51**	.00
Team orientation (TO)	3.93 ± 0.88	3.85 ± 0.90	0.35	.19
Exertion (Ex)	3.27 ± 0.84	3.21 ± 0.76	4.84	.31
Fun (F)	3.61 ± 0.67	3.77 ± 0.74	5.56**	.00
Social influence (SI)	3.10 ± 0.71	2.98 ± 0.73	0.25*	.02

** ($p<0.01$), * ($p<0.05$)

Table 3. *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

d) Canonical correlations: somatic variables and motives

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 between the two sets of variables. 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).

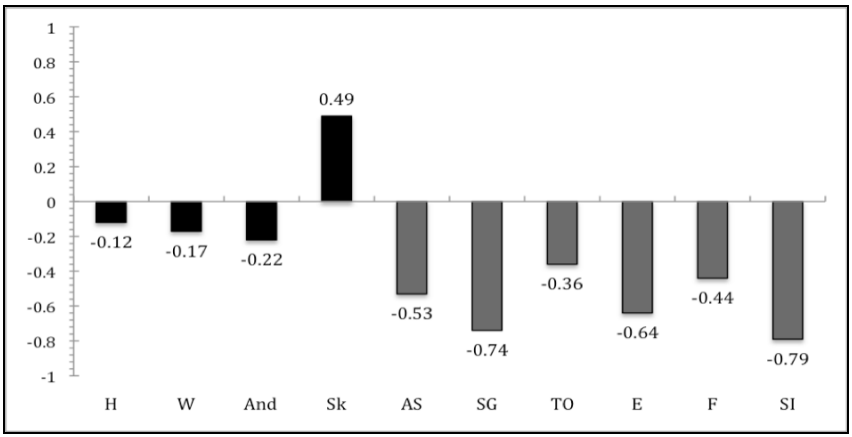

Figure 1. Correlations between somatic variables and motives for participating with the first pair of variates in males. **Legend**: [H] height; [W] weight; [And] Index of androgyny; [SK] sum of skinfolds; [AS] achievement status; [SG] sport goals; [TO] team orientation; [E] exertion; [F] fun; [SI] social influence.

Among girls, the canonical correlations explained 45% of the overlapping variance between domains. The canonical correlate presented in Figure 2 suggests that fatter girls are less motivated to participate in sports. Somatic variables load are positively correlated (sum of skinfolds, +0.72; 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.

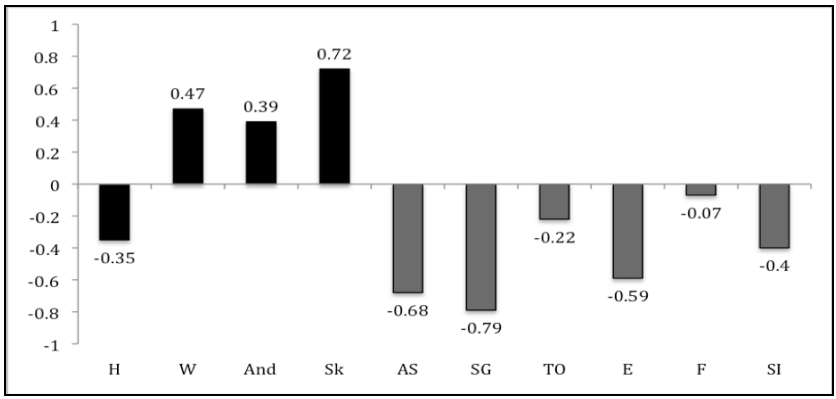

Figure 2. Correlations between somatic variables and motives for participating with the second pair of variates in females. **Legend**: [H] height; [W] weight; [And] Index of androgyny; [SK] sum of skinfolds; [AS] achievement status; [SG] sport goals; [TO] team orientation; [E] exertion; [F] fun; [SI] social influence.

e) Canonical correlations: motives 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.

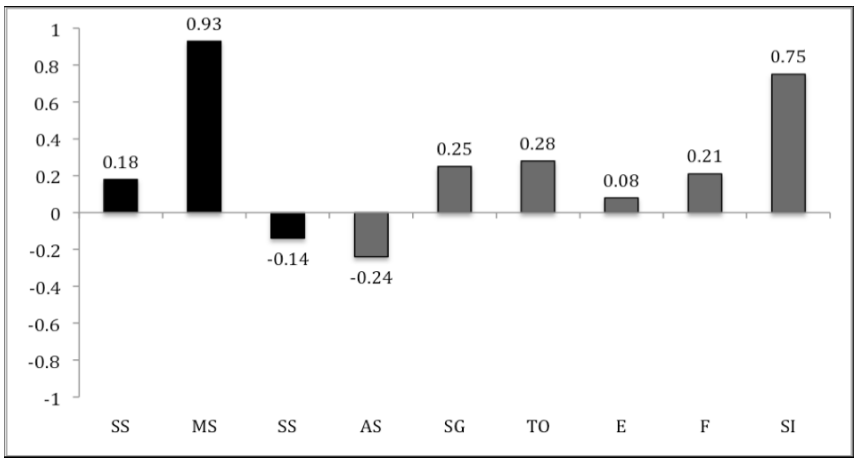

Figure 3. Correlations between motives for participating and social stimulus with respective variates in males. **Legend**: [SS] social stimulus; [MS] material stimulus; [SS] spacial stimulus; [AS] achievement status; [SG] sport goals; [TO] team orientation; [E] exertion; [F] fun; [SI] social influence.

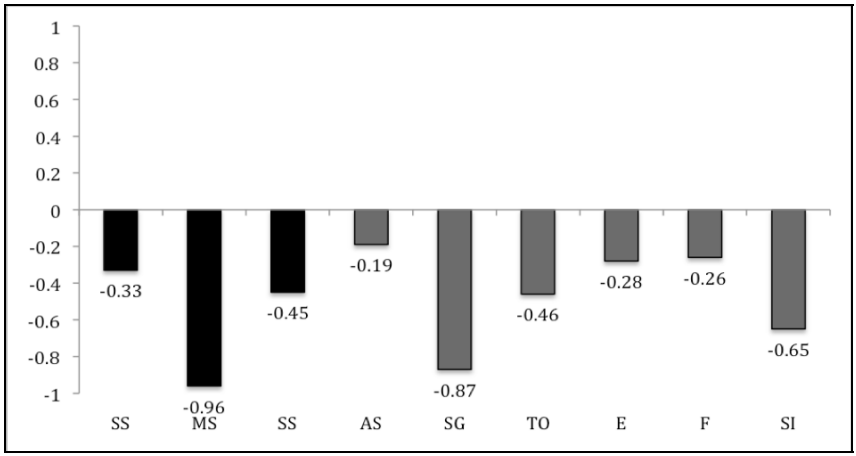

Figure 4. Correlations between motives for participating and social stimulus with respective variates in females. **Legend**: [SS] social stimulus; [MS] material stimulus; [SS] spacial stimulus; [AS] achievement status; [SG] sport goals; [TO] team orientation; [E] exertion; [F] fun; [SI] social influence.

For girls, the canonical correlation expresses a direct association between lack of social incentives and motivation for participating (Figure 4). 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).

DISCUSSION AND CONCLUSIONS

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 4. 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.

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".

Table 4. Summary of factors extracted from the 30-reason questionnaire of Gill *et al.* (1983) in different studies.

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

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.

Environmental factors related to physical activity and inactivity are a topic of current concern. Area of residence, availability and proximity of facilities, safety considerations, among other factors, receive most attention. More recently, emphasis has shifted to the "built environment." The relevance of the preceding for opportunities to be physically active or inactive is seemingly obvious. What is lacking in discussions is consideration of potential interactions among aspects of the built environment (spatial stimuli for activity – playgrounds, open spaces, swimming pools, gymnasia, etc.), materials for activity (material stimuli – bicycles, roller or in-line skates, balls, rackets, ropes, etc.), and social organizations for activity (social centers – sport clubs, recreation centers, folk and theater groups, church organizations, etc.). Associations between motives for participation in organized sport and components of the environment (built, material, social) were considered in the sample of Portuguese adolescents. Results of sex-specific canonical correlation analyses indicated generally similar results for males and females. Scores on the three environmental components were directly associated with levels of motivation for participating. Among females, limited material stimuli wich is maily a familial dependent variable was related with an amotivated state for participating in sports.

REFERENCES

Ávila P, Vasconcelos Raposo J (1999). Factores de motivação para a prática desportiva em jovens da ilha Graciosa. *Dissertação de licenciatura*. Universidade de Trás-os-Montes e Alto Douro.

Coelho e Silva MJ, Malina RM, Sobral FJ (2000). Adiposity. Motor Fitness and Motivation for Sport in Boys 16-18 Years of Age. *Medicine and Science in Sports and Exercise*. 32 (5): S96.

Coelho e Silva M, Sobral F, Malina RM (2003). *Determinância sociogeográfica da prática desportiva na adolescência*. Universidade de Coimbra, Fundação para a Ciência e a Tecnologia.

Costa R (1991). Factores de motivação dos jovens praticantes de voleibol: estudo exploratório da diferença entre sexos no escalão etário 12-14 anos. *Dissertação de licenciatura*. Faculdade de Ciências do Desporto e Educação Física – Universidade do Porto.

Costa R (1993). O estilo de vida dos alunos do 11º ano e a sua motivação para a prática das actividades desportivas na Escola Secundária da Baixa da Banheira. *Boletim da Sociedade Portuguesa de Educação Física*. 7/8. Primavera/Verão.

Cruz J, Costa F (1988). *Motivação para a prática do voleibol e razões para o abandono*. Universidade do Minho.

Cruz J, Cista F, Rodrigues R, Ribeiro F (1988). Motivação para a competição e prática desportiva. *Revista Portuguesa de Educação*. 1 (2): 113-124.

Cruz J, Cunha A (1990). Avaliação Psicológica. *Sete Metros*. 7 (38): 51-58.

Cruz J, Viana M (1989). Motivation in competitive team sports: a study of Portuguese volleyball and handball participants and dropouts. *7th World Congress of Sport Psychology*. Singapore

DeKnop P, Engstrom LM, Skirstad B, Weiss MR (1996) *Worldwide Trends in Youth Sport*. Champaign, IL: Human Kinetics.

Ewing ME, Seefeldt V (1988) *Participation and attrition patterns in American agency-sponsored and interscholastic sports: An executive summary*. East Lansing: Michigan State University. Institute for the Study of Youth Sports.

Figueiredo AJ, Coelho e Silva MJ, Sobral FJ (2002). Níveis de aptidão física e motivação para a prática desportiva nas etapas iniciais de preparação de jovens futebolistas. *Actas Congreso Científico Internacional de Fútbol*. Salamanca (Espanha). 17-18. [CD-ROM]

Fonseca A, Fontaínhas M (1993). Participation motivation in Portuguese competitive gymnastics. *Congreso Mondial de la Actividad Fisica y el Deporte*. Universidad de Granada.

Fonseca A, Ribeiro A (1994). Participation motives for trampoline's practice: a study with elit athletes. *23rd International Congress of Applied Psychology*. Madrid - Spain.

Gill D, Gross J, Huddleston S (1983). Participation motivation in youth sports. *International Journal of Sport Psychology*. 14:1-14.

Gould D, Feltz D, Weiss M (1985). Motives for participating in competitive youth swimming. *International Journal of Sport Psychology*. 16:126-140.

Lohman TG, Roche AF, Martorell R, Eds (1988). *Anthropometric standardization reference manual*. Human Kinetics Publishers, Inc. Champaign, Illinois.

Pimentel J (1993). Estudo sobre a motivação para a prática do basquetebol. *Dissertação de licenciatura*. Faculdade de Ciências do Desporto e Educação Física – Universidade do Porto.

Siegel SR, Pena Reyes ME, Cárdenas Barahona EE, Malina RM (2001). Motivation for sport discontinuing sport in normal weight and overweight Mexican youth. *Medicine and Science in Sports and Exercise*. 33 (abstract).

Siegel SR, Pena Reyes ME, Cárdenas Barahona EE, Malina RM (this volume). Organized sport among youth Mexican Youth. In MJ Coelho e Silva, AJ Figueiredo, MT Elferink-Gemser, R M Malina (Eds). *Children and Youth in Organized Sport*, 2nd edition. Coimbra: Imprensa da Universidade de Coimbra.

Serpa S (1990). Motivação para a prática desportiva. In F Sobral, A Marques (Coordenadores). *FACDEX: Desenvolvimento somato-motor e factores de excelência desportiva na população escolar portuguesa*. Ministério da Educação – Desporto Escolar. 101-106.

Serpa S (1992). Motivação para a prática desportiva. In F Sobral, A Marques (Coordenadores). *FACDEX: Desenvolvimento somato-motor e factores de excelência desportiva na população escolar portuguesa – Volume 2: relatório parcelar da área do grande Porto*. Ministério da Educação – Desporto Escolar. 89-97.

Serpa S, Frias J (1990). Estudo da relação professor/aluno em ginástica de representação e manutenção. *Dissertação de licenciatura*. Faculdade de Motricidade Humana – Universidade Técnica de Lisboa.

Varela-Silva MI (1993). Influência do sexo e do estatuto menarcal na motivação para a prática de actividades desportivas em dois grupos étnicos da zona suburbana de Lisboa. *Boletim da Sociedade Portuguesa de Educação Física*. 7/8: Inverno/Primavera.

Vasconcelos Raposo J, Figueiredo A (1997). Factores de motivação para a prática desportiva em estudantes da UTAD. *Dissertação de licenciatura*. Universidade de Trás-os-Montes e Alto Douro.

Vasconcelos Raposo J, Figueredo A, Granja P (1996). *Factores de motivação dos jovens para a prática desportiva*. Universidade de Trás-os-Montes e Alto Douro.

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CHAPTER 5: IMPORTANCE OF VALUES IN THE COACHING PROCESS

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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.

a) 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 may 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).

b) 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!

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.

SPORTING VALUES

In light of these arguments, coaches are faced with a number of dilemmas when they begin coaching children. Several dilemmas 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.

PROVIDING GOOD COACHING

a) 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.

b) 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)

[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.

- 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 and complex process but one that cannot be avoided. We should also be 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!

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.

REFERENCES

Brustad RJ (1993). Youth in sport: Psychological considerations. In RN Singer, M Murphy, LK Tennant (eds): *Handbook of Research in Sport Psychology*. New York: Macmillan

Bouchard C (1999). Genetics and the future of sport. In R Malina (Ed): Youth *Sports in the 21st Century*. Institute for the Study of Youth Sports. Michigan State University. East Lansing. Michigan. 23-26th May, Lansing MI, Michigan State University. (Abstract).

Chataway C, Goodhart R (1968). *War Without Weapons*. London: Allen

Coles R (1998). *The Moral Intelligence of Children*. London: Bloomsbury.

De Knop P, Wylleman P, Theeboom M, De Martelaer K, Van Puymbroek L, Wittock H (1994). *Youth Friendly Sport Clubs*. Brussels: VUBPress.

Dietrich M (1998). Personal communication.

Dixon (2000). A justification of moderate patriotism in sport. In T Tannsjo, C Tamburrini (Eds): *Values In Sport*. London: E & FN Spon.

Franke WW, Berendonke B (1997). Hormonal doping and the androgenization of athletes: A secret program of the German Democratic Republic government. *Clinical Chemistry*. 43.7.1262-1279.

Glassford G (1989). Sport and educational values: New stakes as the year 2000 draws near. In F Landry (Ed): Sport *in The Third Millenium*. Quebec: Presses de l'Université de Laval

Lee MJ, Austin H (1988) Dimensions of coaching behaviour in children's sport. *Report to the Research Committee of the National Coaching Foundation. Headingley*. Leeds. Yorkshire. England.

Lee MJ, Balchin N (1996). Social influences on values in young athletes. *Journal of Sport Sciences*. 15. 92-3.

Lee MJ, Whitehead J, Balchin N (2000). The measurement of values in youth sport: Development of the Youth Sport Values Questionnaire. *Journal of Sport and Exercise Psychology*. 22. 4. 307-326.

Lee MJ, Whitehead J, Ntoumanis N, Hatzigeorgiadis A (2001). Goal orientations as mediators of the influence of values on sporting attitudes in young athletes. *Paper presented at the 10th World Congress of Sport Psychology*. Skiathos. Greece. May 30th.

Mielke R, Balke S (1995). Structure and preferences of fundamental values of young athletes. Do they differ from non-athletes and from young people with alternative leisure activities. *International Review of the Sociology of Sport*. 30. 3-4. 419-437.

Morgan WJ (2000) Sport as the moral discourse of nations. In T Tannsjo, C Tamburrini (Eds): *Values in Sport*. London: E & FN Spon.

Munthe C (2000). Selecting champions: Making winners in the age of genetic technology. In T Tannsjo, C Tamburrini (Eds): *Values in sport*. London: E & FN Spon.

Potter S (1947). *Theory and Practice of Gamesmanship. or The Art of Winning Without Actually Cheating*. London: Hart-Davis.

Rokeach M (1973). *The Nature of Human Values*. New York: The Free Press of Glencoe.

Schwartz S (1992). Universals in the structure and content of values: Theoretical advances and empirical tests in 20 countries. In MP Zanna (Ed): *Advances in Experimental Social Psychology*. Vol. 25. New York: Academic Press.

Smith RE, Smoll FL, Curtis W (1979) Coach effectiveness training: A cognitive-behavioral approach to enhancing relationship skills in youth sport coaches. *Journal of Sport Psychology. 1. 59-75.*

Sport England (2002) Information sheet: Basic facts about sport. London: Sport England. (*http//www.sportengland.org/resources/info/basic.htm*).

Tannsjo T (2000). Is it fascistiod to admire sports heroes? In T Tannsjo, C Tamburrini (Eds): *Values in Sport*. London: E& FN Spon.

Tannsjo T, Tamburrini C (2000). *Values in Sport*. London: E & FN Spon.

Tasmanian State School Sport Council (1983). *A child is not a little adult: modified approaches to Australian sport.* Hobart: Division of Recreation. Education Department.

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CHAPTER 6: PARENTAL INFLUENCES ON YOUTH SPORT PARTICIPATION

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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.

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 *et al*., 1984) and sport domains (Eccles and Harold, 1991). The model has also been successfully applied to studies of children's physical activity (Brustad, 1993, 1996; Dempsey *et al*., 1993; Kimiecik *et al*., 1996; Kimiecik and 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.

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.

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

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).

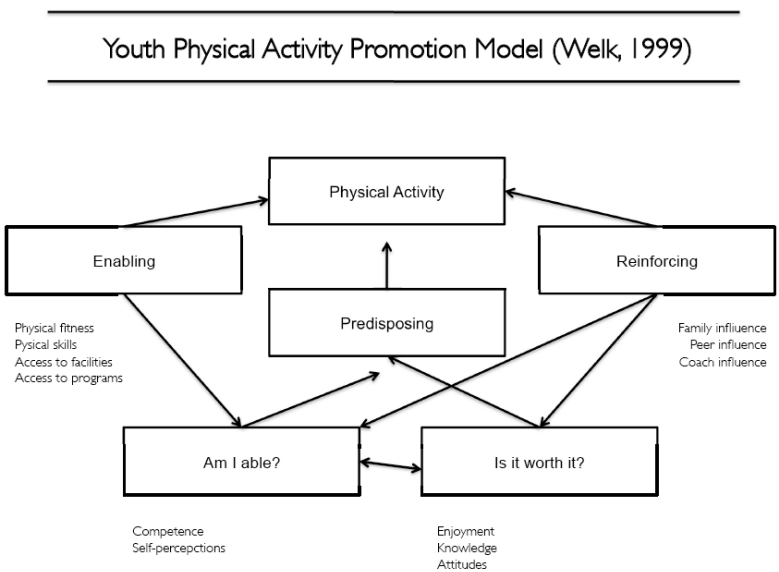

Figure 1. Youth Physical Activity Promotion Model

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.

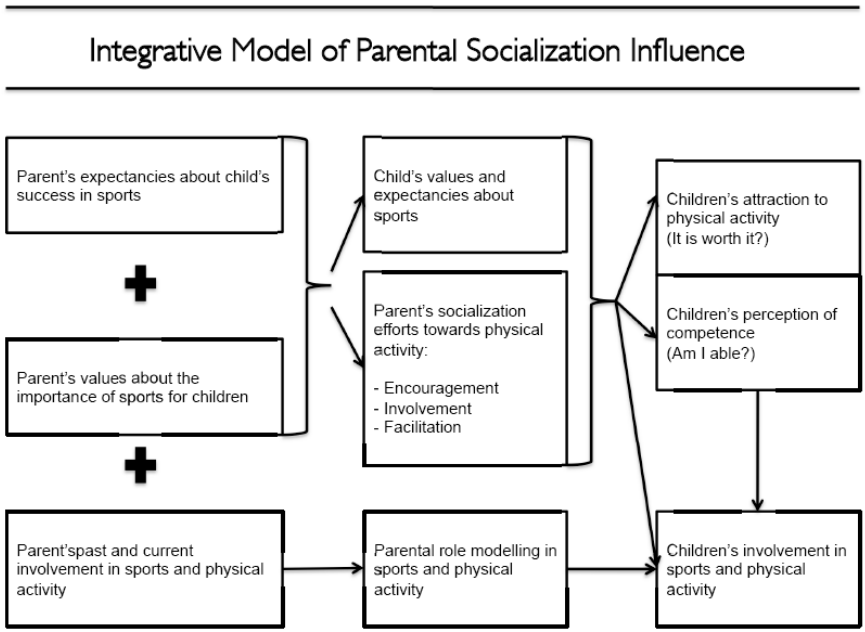

Figure 2. Integrative Model of Parental Socialization Influence

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 "learned-helplessness", 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.

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.

REFERENCES

Ames C (1992). Achievement goals, motivational climate, and motivational processes. In GC Roberts (Ed). *Motivation in sport and exercise* (pp.161-176). Champaign, IL: Human Kinetics.

Ames C, Archer J (1988). Achievement goals in the classroom: Students' learning strategies and motivational processes. *Journal of Educational Psychology*, 80(3), 260-267.

Averill PM, Power TG (1995). Parental attitudes and children's experiences in soccer: Correlates of effort and enjoyment. *International Journal of Behavioral Development*, 18, 263-276.

Babkes ML, Weiss MR (1999). Parental influence on children's cognitive and affective responses to competitive soccer participation. *Pediatric Exercise Science*, 11, 44-62.

Brown BA, Frankel BG, Fennell MP (1989). Hugs or shrugs: Parental and peer influence on continuity of involvement by female adolescents. *Sex Roles*, 20, 397-409.

Brustad RJ (1988). Affective outcomes in competitive youth sport: The influence of intrapersonal and socialization factors. *Journal of Sport and Exercise Psychology*, 10, 307-321.

Brustad RJ (1993). Who will go out and play? Parental and psychological influences on children's attraction to physical activity. *Pediatric Exercise Science*, 5, 210-223.

Brustad RJ (1996). Attraction to physical activity in urban schoolchildren: Parental socialization and gender influences. *Research Quarterly for Exercise and Sport*, 67(3), 316-323.

Brustad RJ, Babkes ML, Smith AL (2001). Youth in sport: Psychological considerations. In RN Singer, HA Hausenblas, CM Janelle (Eds.), *Handbook of sport psychology* (2nd ed., 604-635). New York: John Wiley and Sons.

Brustad RJ, Partridge JA (2002). Parental and peer influence on children's psychosocial development through sport. In FL Smoll, RE Smith (Eds.), *Children and youth in sport: A biopsychosocial perspective* (2nd ed., pp. 187-210). Dubuque, IA: Kendall-Hunt Publishing.

Brustad RJ, Weiss MR (1987). Competence perceptions and sources of worry in high, medicum, and low competitive trait-anxious young athletes. *Journal of Sport Psychology*, 9, 97-105.

Cooley CH (1902). *Human nature and the social order*. New York: Scribner's.

Dempsey JM, Kimiecik JC, Horn TS (1993). Parental influence on children's moderate to vigorous physical activity population: an expectancy-value approach. *Pediatric Exercise Science*, 5, 151-167.

Duda JL (1992). Sport and exercise motivation: A goal perspective analysis. In G Roberts (Ed). *Motivation in sport and exercise* (57-91). Champaign, IL: Human Kinetics.

Duda JL (1997). Perpetuating myths: A response to Hardy's 1996 Coleman Griffith address. *Journal of Applied Sport Psychology*, 9(2), 303-309.

Duda JL, Hom HL (1993). Interdependencies between the perceived and self-reported goal orientations of young athletes and their parents. *Pediatric Exercise Science*, 5, 234-241.

Ebbeck V, Becker SL (1994). Psychosocial predictors of goal orientations in youth soccer. *Research Quarterly for Exercise and Sport*, 65, 355-362.

Eccles-Parsons J, Adler TF, Futterman R, Goff SB, Kaczala CM, Meece JL, Midgley C (1983). Expectancies, values, and academic behaviors. In J Spence, R Helmreich (Eds). *Achivement and achievement motives: Psychological and sociological approaches* (75-146). San Francisco: Freeman.

Eccles J, Adler TF, Kaczala CM (1982). Socialization of achievement attitudes and beliefs: Parental influences. *Child Development*, 53, 310-321.

Eccles J, Adler TF, Meece JL (1984). Sex differences in acheivement: A test of alternate theories. *Journal of Personality and Social Psychology*, 46, 26-43.

Eccles JS, Harold R (1991). Gender differences in sport involvement: Applying the Eccles' expectancy-value model. *Journal of Applied Sport Psychology*, 3, 7-35.

Felson RB, Reed M (1986). The effect of parents on the self-appraisals of children. *Social Psychology Quarterly*, 49, 302-308.

Feltz DL, Lirgg CD, Albrecht RR (1992). Psychological implications of competitive running in elite young distance runners: A longitudinal analysis. *The Sport Psychologist*, 6, 128-138.

Gould D, Eklund R, Petlichkoff L, Peterson K, Bump L (1991). Psychological predictors of state anxiety and performance in age-group wrestlers. *Pediatric Exercise Science*, 3, 198-208.

Green BC, Chalip L (1997). Enduring involvement in youth soccer: The socialization of parent and child. *Journal of Leisure Research*, 29, 61-77.

Greendorfer SL (2002). Socialization processes and sport behavior. In T Horn (Ed). *Advances in Sport Psychology* (2nd ed., 377-401). Champaign, IL: Human Kinetics.

Greendorfer SL, Lewko JH, Rosengren KS (2002). Family and gender-based influences in sport socialization of children and adolescents. In FL Smoll, RE Smith (Eds). *Children and youth in sport: A biopsychosocial perspective* (2nd ed., 153-186). Dubuque, IA: Kendall-Hunt Publishing.

Harter S (1978). Effectance motivation reconsidered: toward a developmental model. *Human Development*, 21, 34-64.

Harter S (1981). A model of intrinsic mastery motivation in children: Individual differences and developmental change. In WA Collins (Ed). *Minnesota symposium on child psychology* (Vol. 14, 215-255). Hillsdale, NJ: Erlbaum.

Hellstedt JC (1990). Early adolescent perceptions of parental pressure in the sport environment. *Journal of Sport Behavior*, 13, 135-144.

Horn TS, Amorose AJ (1998). Sources of competence information. In JL Duda (Ed). *Advances in sport and exercise psychology measurement* (49-63). Morgantown, WV: Fitness Information Technology.

Horn TS, Hasbrook CA (1986). Informational components influencing children's perceptions of their physical competence. In MR Weiss, D Gould (Eds). *Sport for children and youths* (81-88). Champaign, IL: Human Kinetics.

Horn TS, Hasbrook CA (1987). Psychological characteristics and the criteria children use for self-evaluation. *Journal of Sport and Exercise Psychology*, 9, 208-221.

Horn TS, Weiss MR (1991). A developmental analysis of children's self-ability judgments in the physical domain. *Pediatric Exercise Science*, 3, 310-326.

Kimiecik JC, Horn TS (1998). Parental beliefs and children's moderate-to-vigorous physical activity. *Research Quarterly for Exercise and Sport*, 69 (2): 163-169

Kimiecik JC, Horn TS, Shurin CS (1996). Relationships among children's beliefs, perceptions of their parents' beliefs, and their moderate-to-vigorous physical activity. *Research Quarterly for Exercise and Science*, 67(3), 324-336.

Leff SS, Hoyle RH (1995). Young athletes' perceptions of parental support and pressure. *Journal of Youth and Adolescence*, 24, 187-203.

Lewthwaite R, Scanlan TK (1989). Predictors of competitive etrait anxiety in male youth sport participants. *Medicine and Science in Sport and Exercise*, 21, 221-229.

McCullagh P, Matzkanin K, Shaw SD, Maldonado M (1993). Motivation for participation in physical activity: A comparison of parent-child perce3ived competence and participation motives. *Pediatric Exercise Science*, 5, 224-233.

Mead GH (1934). *Mind, self and society*. Chicago: University of Chicago Press.
Nicholls JG (1984). Conceptions of ability and achievement motivation. In R Ames, C Ames (Eds). *Research on motivation in education: Student motivation* (Vol. 1, 39-73). New York: Academic Press.
Nicholls JG (1989). *The competitive ethos and democratic education*. Cambridge, MA: Harvard University Press.
Ommundsen Y, Vaglum P (1991). Soccer competition anxiety and enjoyment in young boy players: The influence of perceived competence and significant others' emotional involvement. International *Journal of Sport Psychology*, 22, 35-49.
Passer MW (1983). Fear of failure, fear of evaluation, perceived competence and self-esteem in competitive trait-anxious children. *Journal of Sport Psychology*, 5, 172-188.
Power TG, Woolger C (1994). Parenting practices and age-group swimming: A correlational study. *Research Quarterly for Exercise and Sport*, 65, 59-66.
Roberts GC (1975). Win-loss causal attributions of little league players. *Mouvement*, 7: 315-322.
Robinson DW, Howe BL (1989). Appraisal variable/affect relationships in youth sport: A test of Weiner's attributional model. *Journal of Sport and Exercise Psychology*, 11: 431-443.
Scanlan TK (2002). Social evaluation and the competition process: A developmental perspective. In FL Smoll and RE Smith (Eds). *Children and youth in sport: A biopsychosocial perspective* (2nd ed.). Dubuque, IA: Kendall/Hunt.
Scanlan TK, Lewthwaite R (1984). Social psychological aspects of competition for male youth sport participants: I. Predictors of competitive stress. *Journal of Sport Psychology*, 6: 208-226.
Scanlan TK, Lewthwaite R (1986). Social psychological aspects of competition for male youth sport participants: IV. Predictors of enjoyment. *Journal of Sport and Exercise Psychology*, 8: 25-35.
Scanlan TK, Stein GL, Ravizza K (1989). An in-depth study of former elite figure skaters: II. Sources of enjoyment. *Journal of Sport and Exercise Psychology*, 11: 65-83.
VanYperen NW (1995). Interpersonal stress, performance level, and parental support: a longitudinal study among highly skilled young soccer players. *The Sport Psychologist*, 9: 225-241.
Weiner B (1974). *Achievement motivation and attribution theory*. Morristown, NJ: General Learning Press.
Weiner B (1980). *Human motivation*. New York: Holt, Rinehart, and Winston.
Weiss MR, Wiese DM, Klint KA (1989). Head over heels with success: The relationship between self-efficacy and performance in competitive youth gymnastics. *Journal of Sport and Exercise Psychology*, 11: 444-451.
Welk GJ (in press). The Youth Physical Activity Promotion Model: A conceptual bridge between theory and practice. *Quest*, 51: 5-23.
White SA (1996). Goal orientation and perceptions of the motivational climate initiated by parents. *Pediatric Exercise Science*, 8: 122-129.
Wold B, Anderssen N (1992). Health promotion aspects of family and peer influences on sport participation. International *Journal of Sport Psychology*, 23: 343-359.

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CHAPTER 7: ROLE OF PARENTAL SUPPORT IN SPORTS SUCCESS OF TALENTED YOUNG DUTCH ATHLETES

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Koen A.P.M. Lemmink

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?

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.

RESEARCH IN TALENTED DUTCH CHILDREN

a) 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).

b) 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%).

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).

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

c) 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 (a) has been set at the 0.05 level.

RESULTS

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.

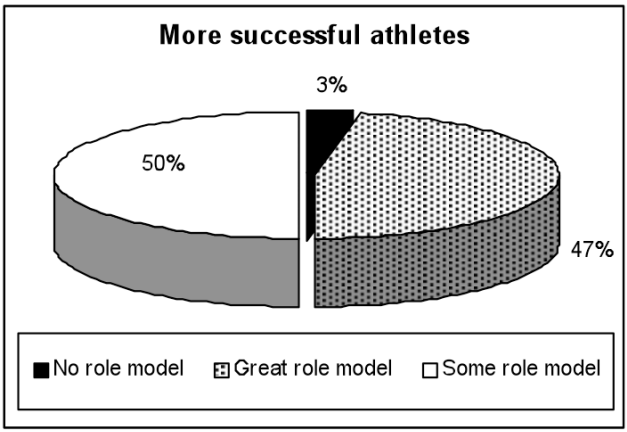

Figure 1a. Parental role modeling of youth athletes with high degree of success.

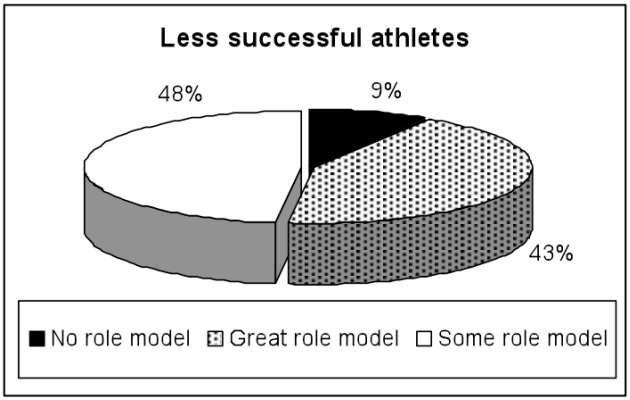

Figure 1b. Parental role modeling of youth athletes with low degree of success.

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.

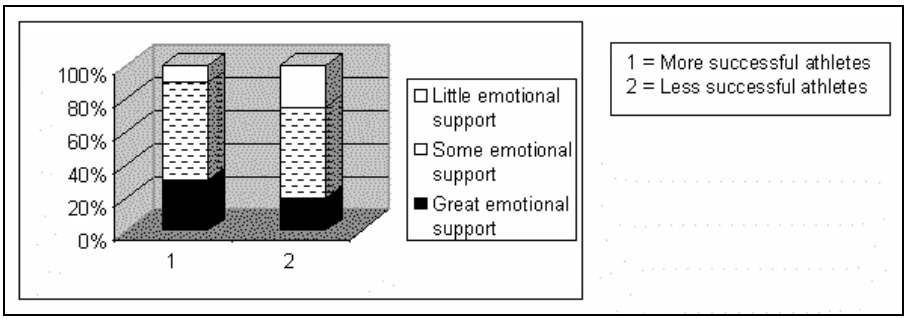

Figure 2. Parental emotional support of youth athletes with varying degrees of success.

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.

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.

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.

REFERENCES

Alabin V, Nischt G,. Jefimov W (1980). Talent selection. *Modern athlete and coach*. 36-37.

Biddle JH, Chatzisarantis N (1999). Motivation for a physically active lifestyle through physical education. In Y Vanden Auweele, F Bakker, S Biddle, M Durand, R Seiler (Eds.). *Psychology for Physical Educators* (5-26). Leeds. UK: Human Kinetics.

Bloom BS (1985). *Developing talent in the young*. New York: Ballantine.

Bouchard C, Malina RM, Pérusse L (1997). *Genetics of fitness and physical performance* (365-371). Champaign. IL: Human Kinetics.
Brustad RJ (1988). Affective outcomes in competitive youth sport: The influence of intrapersonal and socialization factors. *Journal of Sport & Exercise Psychology*. 10. 307-321.
Brustad RJ (1993). Who will go out and play? Parental and psychological influences on children's attraction to physical activity. *Pediatric Science*. 5. 210-223.
Butcher J (1985). Longitudinal analysis of adolescent girl participation in physical activity. *Sociology of Sport Journal*. 12. 91-99.
Côté J (1999). The Influence of the Family in the Development of Talent in Sport. *The Sport Psychologist*. 13. 395-417.
Csikszentmihalyi M, Rathunde K, Whalen S (1993). *Talented teenagers: The roots of success and failure*. New York: Cambridge.
Ericsson KA (1996). The acquisition of expert performance: An introduction to some of the issues. In KA Eriscon (Ed.). *The road to excellence: The acquisition of expert performance in the arts and sciences. sports and games* (1-50). Manwah. NJ: Lawrence Erlbaum.
Ericsson KA, Krampe R, Tesch-Römer C (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*. 100 (3). 363-406.
Giljam MJ (1988). *Sportgedrag en levensloop: een kwalitatief onderzoek naar achtergronden van de sportdeelname in de gemeente Rotterdam*. Culemborg: Bruno.
Hahn A (1990). Identification and selection of talent in Australian rowing. *Exel*. 6. 5-11.
Hahn E (1988). Jeugdtraining. Uit de serie *Sport. Theorie en Praktijk*. Baarn: Uitgeverij Tirion Sport.
Hellstedt JC (1987). The coach/parent/athlete relationship. *The Sport Psychologist*. 1. 151-160.
Hellstedt JC (1995). Invisible players: A family system model. In SM Murphy (Ed.). *Sport Psychology Interventions* (117-146). Champaign. IL: Human Kinetics.
Huizingh, E (1993). *Inleiding SPSS/PC+ 5.0 en Data Entry*. Addison-Wesley Nederland BV.
Lauer RH, Handel WH (1983). *Social psychology: The theory and application of symbolic interactionism*. Englewood Cliffs. NJ: Prentice-Hall.
Lewko JH, Greendorfer SL (1988). Family influences in sport socialization of children and adolescents. In FL Smoll, RA Magill, MJ Ash (Eds.). *Children in sport* (3rd ed.) (287-300). Champaign. Ill.: Human Kinetics.
McCall GJ, Simmons JL (1978). *Identities and interactions*. New York: The Free Press.
McElroy MA, Kirkendall DR (1980). Significant others and professionalized sport attitudes. *The Research Quarterly for Exercise and Sport*. 51. 645-653.
McPherson BD, Brown BA (1988). The structure. processes. and consequences of sport for children. In FL Smoll, RA Magill, MJ Ash (Eds.). *Children in sport* (3rd ed.) (265-286). Champaign. Ill.: Human Kinetics.
Monsaas JA (1985). Learning to be a world-class tennis player. In BS Bloom (Ed.). *Developing talent in young people* (211-269). New York: Ballantine.
Power TG, Woolger C (1994). Parenting practices and age-group swimming: A correlational study. *Research Quarterly for Exercise and Sport*. 65(1). 56-66.
Scanlan TK, Lewthwaite R (1985). Social psychological aspects of competition for male youth sport participants: III. Determinants of personal performance expectancies. *Journal of Sport Psychology*. 7. 389-399.

Scanlan TK, Stein GL, Ravizza K (1991). An in-depth study of former elite figure skaters: III. Sources of stress. *Journal of Sport and Exercise Psychology*. 13. 103-120.
Sloan LA (1985). Phases of Learning. In BS Bloom (Ed.). *Developing talent in young people*. New York: Ballantine.
Stevens, J (1996). *Applied multivariate statistics for the social sciences.* 3rd Edition, Lawrence Erlbaum Associates Publishers, New Jersey.
Stevenson CL (1990). The Early Careers of International Athletes. *Sociology of Sport Journal*. 7. 238-253.
Visscher C, Gemser MT, De Greef MHG (1996.a). Jeugdige topsporters. invloed van ouders en onderwijs 1. *Richting-Sportgericht*. 3.
Visscher C, Gemser MT, De Greef MHG (1996.b). Jeugdige topsporters. invloed van ouders en onderwijs 2. *Richting-Sportgericht*. 4.
Visscher, C, Bakema, R, Elferink-Gemser, MT, Lemmink, KAPM (2003). Waarom jeugdige topturners ermee stoppen. *Richting Sportgericht*.
Weiss MR, Wiese DM, Klint KA (1989). Head over heals with success: The relationship between self-efficacy and performance in competitive youth gymnastics. *Journal of Sport and Exercise Psychology*. 11. 444-451.
Woolger C. Power RG (1993). Parent and sport socialization: Views from the achievement literature. *Journal of Sport Behavior*. 16. 3. 171-189.

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 2:

TRAINABILITY AND READINESS

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CHAPTER 8: EFFECTS OF TRAINING FOR SPORT ON GROWTH AND MATURATION

Robert Malina

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.

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.

a) Size Attained

Average heights of athletes in different sports are expressed relative to percentiles of the growth charts for American boys and girls in Tables 1 and 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 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. 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.

b) 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.

c) 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.

d) 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

(1) Adapted from Malina (1998a, see Malina et al., 2004) which includes the references for specific studies. 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.

e) 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 an earlier chapter of this volume. 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.

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.

a) 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.

b) 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.

b.1.) 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.2.) 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?

b.3.) 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.

d) Training and Biological Maturation

Does regular training 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.

d.1.) 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.

d.2.) 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!

d.3.) 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).

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.

REFERENCES

Clapp JF, Little KD (1995) The interaction between regular exercise and selected aspects of women's health. *American Journal of Obstetrics and Gynecology* 173:2-9.

Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, Mei Z, Curtin LR, Roche AF, Johnson CL (2000): *CDC growth charts: United States.*

Advance Data from Vital and Health Statistics, no 314. Hyattsville, MD: National Center for Health Statistics.
Loucks AB, Vaitukaitis J, Cameron JL, Rogol AD, Skrinar G, Warren MP, Kendrick J, Limacher MC (1992) The reproductive system and exercise in women. *Medicine and Science in Sports and Exercise* 24:S288-293.
Malina RM (1994) Physical growth and biological maturation of young athletes. *Exercise and Sport Sciences Reviews* 22:389-433.
Malina RM (1996) The young athlete: Biological growth and maturation in a biocultural context. In FL Smoll, RE Smith (Eds). *Children and Youth in Sport: A Biopsychosocial Perspective*. Dubuque, IA: Brown and Benchmark, pp 161-186.
Malina RM (1998) Growth and maturation of young athletes: Is training for sport a factor. In KM Chang, L Micheli (Eds): *Sports and Children*. Hong Kong: Williams and Wilkins, pp 133-161.
Malina RM, Bouchard C, Bar-Or O (2004) Growth, Maturation, and Physical Activity, 2nd edition. Champaign, IL: Human Kinetics.

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CHAPTER 9: FUNCTIONAL RESPONSES OF CHILDREN AND ADOLESCENTS TO SYSTEMATIC TRAINING

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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.

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

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.

Instruction and practice have a beneficial influence on skill acquisition in early childhood and during the transition into middle childhood (Malina, 2008). Guided instruction by qualified coaches or trained parents, appropriate motor task sequences, and adequate time for practice are essential components of successful instructional programs at young ages. Focus has been largely on general movement skills in contrast to sport-specific skills. Nevertheless, casual observation of the progress of children during a season of supervised instruction, practice and competition in a given sport clearly shows improvements in general and sport-specific skills. Modifications of sports such as small-sided soccer provide many opportunities for more touches and in turn refinement of ball handling skills.

More systematic approaches are needed to document the specific influence of instruction and practice in a sport on the movement skills of youth. A recent example is a comparison of the motor skills (though not sport-specific skills) and physical fitness of 7 and 8 year old boys exposed to three sessions of soccer instruction and training per week over a nine month period in addition to school physical education and age peers who received only physical education instruction (Erceg et al., 2008). Outcome variables were components of motor proficiency and fitness: coordination, agility, flexibility, movement speed, explosive strength, muscular strength and endurance, static strength and aerobic endurance. On average, boys involved in the soccer program made greater gains than control peers in motor proficiency and fitness over the nine months.

Although the results are interesting, they are limited from two perspectives: boys were not assigned to the soccer and control groups randomly, and body size was not statistically controlled in the analysis. Boys in the experimental group were already enrolled in soccer schools at the start of the study. Growth status per se and changes in growth status over nine months may influence performances on some of the tests used in the study. At these ages, it may be difficult 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 (Malina et al., 2004a).

Related variables also need to be considered in evaluating the influence of sport programs on skill development. Perhaps most important is the environment of sport programs - instructional and practice protocols, quality of coaches and coaching styles, parental involvement and the overall atmosphere of the setting (child-focused, relaxed).

Instruction and practice in movement skills per se and in combinations or modifications of these skills to meet the requirements of specific sports, are beneficial during middle childhood and adolescence. Data dealing with skill acquisition at older ages are, with few exceptions set within the framework of cognitive psychology and relate to relatively simple, discrete movement tasks in contrast to more complex tasks of a sport.

Application of principles of skill acquisition to soccer skills have been summarized (Williams et al., 2003; Williams and Hodges, 2005). Individual differences in age, size, maturity status, fitness, skill, and motivation of young athletes (internal constraints), especially during the transition into puberty and during the adolescent growth spurt and sexual maturation, present a challenge in applying these principles to youth players. In adolescent soccer players 13-15 years of age, for example, age, experience, body size and stage of puberty contribute significantly to indicators of functional capacity (aerobic, power, speed), but considerably less to soccer-specific skills (Malina et al., 2004b, 2005, 2007). The challenge is to incorporate individual differences in internal constraints into instructional and practice situations (environmental constraints) to facilitate the acquisition and refinement of skills.

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 (Blimkie and Sale, 1998; Sale, 1989; Malina, 2006).

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 (Malina, 2006).

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 (Malina et al., 2004a). 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 (Nielsen et al., 1980). 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 (Malina, 2006). Further, it is difficult to partition the effects of the training program from expected changes in performance associated with normal growth.

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 (Malina et al., 2004a).

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 (Malina and Eisenmann, 2003).

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% (Malina et al., 2004a). 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 (Malina et al., 2004a). 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.

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.

LITERATURE

Blimkie CJ, Sale DG (1998) Strength development and trainability during childhood. In E Van Praagh (Ed): *Pediatric Anaerobic Performance*. Champaign, IL: Human Kinetics, pp 193-224.

Erceg M, Zagorac N, Katic R (2008) The impact of football training on motor development in male children. *Collegium Antropologicum* 32:241-247.

Malina RM (2006) Weight training in youth-growth, maturation, and safety: an evidence-based review. *Clinical Journal of Sports Medicine* 16:478-487.

Malina RM (2008) Skill: Acquisition and Trainability. In O Bar-Or and H Hebestreit (Eds), *The Young Athlete*. Oxford, UK: Blackwell Publications, pp 96-111.

Malina RM, Bouchard C, Bar-Or O (2004a) *Growth, Maturation, and Physical Activity*, 2nd edition. Champaign, IL: Human Kinetics.

Malina RM, Cumming SP, Kontos AP, Eisenmann JC, Ribeiro B, Aroso J (2005) Maturity-associated variation in sport-specific skills of youth soccer players aged 13-15 years. *Journal of Sports Sciences* 23:515-522.

Malina RM, Eisenmann JC (2003) Trainability during childhood and adolescence. In RM Malina, MA Clark (Eds), *Youth Sports: Perspectives for a New Century*. Monterey, CA: Coaches Choice, pp 76-93.

Malina RM, Eisenmann JC, Cumming SP, Ribeiro B, Aroso J (2004b) Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. *European Journal of Applied Physiology* 91:555-562.

Malina RM, Ribeiro B, Aroso J, Cumming SP (2007) Characteristics of youth soccer players aged 13-15 years classified by skill level. *British Journal of Sports Medicine* 41:290-295.

Mirwald RL, Bailey DA (1986) *Maximal Aerobic Power*. London, Ontario: Sport Dynamics.

Nielsen B, Nielsen K, Behrendt Hansen M, Asmussen E (1980) Training of "functional muscular strength" in girls 7-19 years old. In K Berg, BO Eriksson (Eds). *Children and Exercise IX*. Baltimore: University Park Press, pp 69-78.

Rowland TW, Boyajian A (1995) Aerobic response to endurance exercise training in children. *Pediatrics* 96:654-658.

Sale D (1989) Strength and power training during youth. In CV Gisolfi, DR Lamb (Eds): *Perspectives in Exercise Science and Sports Medicine*. Volume II. Youth, Exercise, and Sport. Indianapolis. Benchmark Press, pp 165-216.

Williams AM, Hodges NJ (2005) Practice, instruction and skill acquisition in soccer: Challenging tradition. *Journal of Sports Sciences* 23:637-650.

Williams AM, Horn RR, Hodges NJ (2003) Skill acquisition. In T Reilly, AM Williams (Eds), *Science and Soccer*, 2nd edition. London: Routledge, pp 198-213.

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CHAPTER 10: TRAINABILITY OF VO_2max DURING CHILDHOOD AND ADOLESCENCE

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INTRODUCTION

VO_2max develops just like other processes related to growth and maturation during childhood and adolescence. Longitudinal studies show an increase of absolute and relative VO_2max. Absolute VO_2max of untrained children and adolescents increases from about 1.0 l/min at the age of 6 to 2.0 and 2.8 l/min at the age of 15 for girls and boys, respectively. After this age, improvement of untrained boys continues, while VO_2max of untrained girls reaches a plateau (Krahenbuhl et al., 1985). VO_2max relative to body mass shows a different pattern in untrained children. It improves in boys and girls until about 10 years; subsequently, VO_2max remains at a plateau in boys and declines in girls (Krahenbuhl et al., 1985; Bar-Or, 1986; Rowland, 1996).

Although VO_2max is partly determined by genotype, it can be improved with systematic training it is also trainable. Much research has been done with adults and improvements up to 30% have been recorded (Powers and Howley, 2003). The responsiveness of VO_2max to training is also partly determined by genotype (Bouchard et al., 1997). In contrast to adults, less research has been conducted on the responsiveness of VO_2max to training in children and adoescents. The available research also shows variation in results (Baquet et al., 2003; Thompson and Baxter-Jones, 2002), ranging from no significant changes (e.g., Gilliam and Freedson, 1980) to improvements reaching 15% (e.g., Stansky et al., 1979).

The focus of this review is the trainability of VO_2max in children and adolescents. The review is set within the context of three stages of sport development that characterize childhood and adolescence (Côté and Hay, 2002) which are set within the deliberate practice model of expertise (Ericsson, 2003; Ericsson et al., 1993). The first stage covers the sampling years (6-12) during which there is high frequency of deliberate play and a low frequency of deliberate practice. The second stage is the specializing years (13-15) which are characterized by similar amounts of deliberate play and deliberate practice. The third stage, the investment years (16+) is dominated

by deliberate practice with low frequency of deliberate play. Relevant questions are the following: Are changes in VO_2max due only to growth and maturation or are they also due to training? Do changes in VO_2max occur in each of the sport developmental stages? What is the magnitude of change in VO_2max in each of the stages?

METHODS

The focus of this review is literature over the past 15 years (since 1993). Articles were collected by means of computer search through relevant data bases (Web of Science, PubMed, and Google Beta). The search items were as follows: "maximal oxygen uptake", "VO_2max", "endurance training", "aerobic training", "anaerobic training" "effects of training", "physical training", "trainability" and "cardiovascular system". The results were then refined for "children", "adolescents", "young athletes", "youth", "teenagers", "pubertal" and "prepubertal". Articles were selected based on abstract reading. Only studies of healthy, non-obese children and adoscents were included.

Selected articles were reviewed with a focus on the following: number of participants and sex, chronological age, characteristics of the training intervention (content, duration, intensity, frequency, length), presence or absence of control group, absolute and/or relative values for VO_2max at the beginning and end of the training program, percentage change and significance of the change.

VO_2max is the most commonly used term for maximal achieved oxygen uptake. However, VO_2max in children and adolescents is characterized by a plateau and a real maximal value is not always attained. The highest level of VO_2 is used is expressed as peak VO_2. Although peak VO_2 is generally treated as equivalent to VO_2max in children and adolescents (Rowland 1993), the term VO_2max is used in this review.

RESULTS

VO_2max *without a training intervention*

Studies of VO_2max without a training intervention in children and adolescents are summarized in Table 1. Studies of VO_2max of trained and untrained children and adolescents should be noted. Untrained youth generally show lower levels of VO_2max compared to trained youth with relative values ranging from 35.2 to 48.0 ml/kg/min in boys and from 35.8 to 41.7 ml/kg/min

in girls. Absolute VO_2max for untrained boys and girls 9 to 16 years are also lower (Dencker et al., 2006, 2007; Gursel et al., 2004; Impertone et al., 2006; Pate et al., 2007; Rowland et al., 2000; Vinet et al., 2003). Two studies investigated relative VO_2max across several age-categories spanning childhood and adolescence. Between 5 and 13 years of age, relative VO_2max increased by 36% in boys and by only 10% in girls (Gursel et al., 2004), while between 12 and 19 years, relative VO_2max increased by 6.7% in boys and decreased by 5.5% in girls (Pate et al., 2007).

Trained boys 10 to 18 years generally show a relative VO_2max between 50 and 70 ml/kg/min (Cleuziou et al., 2002; Cubero et al., 2000; Eisenman et al., 2001; Noury et al., 2004; Thevenet et al., 2007; Tolfrey et al., 2006). Only study of trained boys reported a relative VO_2max <50 ml/kg/min (Cubero et al., 2000). In this study, 17 year old male soccer player had a mean relative VO_2max of 48.0 ml/kg/min, whereas cyclists and canoeists had, respectively, values of 57.0 and 53.0 ml/kg/min. The highest relative VO_2max in boys was observed in 17 year old elite distance runners, 67.5 ml/kg/min (Eisenmann et al., 2001). Girls in the latter study had relative VO_2max of ~55 ml/kg/min, which was considerably higher than 40.2 ml/kg/min in trained prepubertal children (Noury et al., 2004).

Only a few studies report absolute VO_2max in trained children and adolescents. Levels up to 2.50 l/min were reported in boys up to about 12 years which increased to 4.39 l/min in boys 18 years of age. Girls show levels of 1.31 to 2.28 l/min to about 12 years and of 2.89 l/min at 17 years (Eisenman et al., 2001; Noury et al., 2004; Tolfrey et al., 2006).

VO_2max values with a training intervention

a) Sampling years (about 6-12 years)

An overview of results are reported in Table 2. Given the variation in study designs and protocols, it is most effective to consider studies separately.

In a study of 14 prepubertal girls, 5 (9.3±0.5 years) participated in a swim training program of about one year duration whereas the control group of 9 girls (9.3±0.4) had no additional training (Obert et al., 1996). The experimental group trained 5 times per week for 2 hours, spread over 2 sessions a day. Training consisted of various activities to improve swimming technique and physiological capacity. All girls were tested on a swim ergometer (only arms involved) at the beginning and after one year. Both experimental and control groups increased significantly in absolute VO_2max by

39% and 13%, respectively, from 0.79±0.12 to 1.10±0.17 l/min and from 0.69±0.10 to 0.78±0.12 l/min. The experimental group showed significant improvement of relative VO_2max from 26.2±4.4 to 33.8±5.0 ml/kg/min (+29%) while that of the control group remained stable at about 24.7 ml/kg/min.

Thirty-eight boys, 11.5 years of age, participated in a sport-specific training study over 18 months (Vamvakoudis et al., 2007). Of this group, 20 boys formed The experimental group (n=20) had 2 years of basketball experience while the control group (n=18) had no sport experience and participated in normal physical education at school, 2 or 3 times a week for 40 minutes during the course of the study. The experimental group had 6 mixed basketball-related training sessions of different intensities per week each 90 minutes in duration. The boys were tested every 6 months with an incremental treadmill running test. The experimental group had significantly higher absolute and relative VO_2max at the beginning and end of the training period. Both the control and experimental groups improved significantly in absolute VO_2max. The control group increased in absolute VO_2max by 24.2% from 2.11±0.34 to 2.62±0.30 l/min and in relative values by 8.1% from 42.2± 5.3 to 45.6±6.4 ml/min/kg. The experimental group improved in absolute VO_2max by 34.6% from 2.31±0.41 to 3.11±0.50 l/min and in relative values by 8.6% from 51.4±3.9 to 55.8± 4.1 ml/min/kg. Of interest, the relative gain in VO_2max per unit body mass was virtually identical in the control and experimental groups, ~8%.

An experimental group (6 girls, 6 boys, 10.4±0.3 years) trained for 13 weeks, 3 times per week for 1 hour. The protocol involved interval training (running at 90% HR max), continuous training (running at 80% HR max) and other aerobic activities including soccer, basketball and swimming (Mandigout et al., 2002). The control group (3 girls, 4 boys, 10.7±0.5 years) participated in regular activities. VO_2max was measured with an incremental bicycle ergometer test. After 13 weeks, the experimental group increased significantly in relative VO_2max, 41.3±8.3 to 47.9±10.7 ml/kg/min (+16.0%), while the control group showed no improvement in relative VO_2max although their mean value, 45.9 ml/kg/min was rather high compared to those in the experimental training program. Unfortunately, absolute values and differences between boys and girls were not reported.

Comparable results were noted in a study 7 boys and 11 girls (10.0±0.8 years) who were randomly divided into experimental and control groups (Noury et al., 2005). The experimental group had a training program of 8 weeks which included normal physical education lessons and the two sessions per week of 30 minutes high intensive running. The control group had normal physical education with no additional training. All children did an

incremental test on a bicycle ergometer at the beginning and end of the study. Relative VO_2max of the experimental group improved significantly from 37.4±7.3 to 43.2± 7.6 ml/min/kg (+15%), while relative VO_2max of the control group remained the same over the 8 weeks, 38.8 ml/kg/min. Unfortunately, neither absolute values nor sex differences were reported.

A sample of 19 children (10 girls, 9 boys) 10-11 years followed a 13-week training program of continuous (>80% HR max) and interval (>90% HR max) activities for 1.0-1.5 hours per session, 3 times per week, while 16 children (7 girls, 9 boys) of the same age served as a control group (Obert et al., 2003). All children performed an incremental cycle ergometer test before and after the program. Relative VO_2max increased significantly in the experimental group, 40.9±8.9 to 44.2±8.4 ml/min/kg in girls and 44.1±6.1 to 50.9±6. ml/min/kg in boys, 8.1% and 15.4%, respectively. This means an improvement of VO2-max of respectively 8.1% and 15.4%. Relative VO_2max of the control group, on the other hand, did not change, 42.4 and 51.5 ml/kg/min in girls and boys, respectively, after 13 weeks. Absolute values were not reported.

Using a 7 week training program,13 boys and 20 girls (9.5±0.9 years) participated in normal physical education lessons plus 2 additional training sessions per week (Baquet et al., 2002). The latter consisted of 30 minutes of short high intermittent exercise (10 and 20 second sprints). Ten boys and 10 girls (9.9±0.4 years) comprised a control group which had only normal physical education lessons. VO_2max was estimated with a graded field running test. The experimental group improved significantly in absolute VO_2max, 1.54±0.35 to 1.68±0.36 l/min, and in relative VO_2max, 43.9±6.2 to 47.5±7.2 ml/min/kg (+9.1% and +8.2%, respectively). The control group did not change in either absolute or relative VO_2max, 1.62 l/min and 46.2 ml/kg/min, respectively. Sex differences were not reported.

Comparable results were obtained in a study of 40 girls (9.1±0.1 years) attending a summer camp (Eliakim et al., 2001). An experimental group (n=20) followed 2 training sessions of 45 minutes per day, 5 days per week over 5 weeks. The sessions consisted of endurance activities, 50% running activities and 50% ball sports. All activities were performed as games and intensity levels were not reported. The remaining girls (n=20) served as a control group who did not have special training sessions. VO_2max was measured with an incremental bicycle ergometer test. The experimental group increased significantly in relative VO_2max (+9.5%). Post-training VO_2max was 1.45 l/min and 45 ml/min/kg in the experimental group. Exact values, pre-training values and values for the control group were not reported.

Using a 13 weeks protocol, 17 girls (10.5±0.4 years) and 18 boys

(10.7±0.4 years) trained 3 times per week in 1.0-1.5 hour sessions of interval training (90% HR max), continuous training (75-85% HR max) and several aerobic activities, while 22 girls (10.5±0.9) and 28 boys (10.5±0.5 years) formed a control group which has no special training (Mandigout et al., 2001). An incremental bicycle ergometer test was used. Experimental girls improved significantly in both absolute (1.30±0.2 to 1.57±0.2 l/min, +20.8%) and relative (38.6±4.4 to 41.9±4.6 ml/min/kg, +8.5%) VO_2max. Corresponding improvements in experimental boys were somewhat less but significant,1.70±0.3 to 1.84±0.3 l/min (+8.2%) in absolute and 47.2±7.9 to 49.2±7.1 ml/min/kg (+4.2%) in relative VO_2max. The control group also improved in absolute VO_2max (girls +6.9%, 1.40 to 1.50 l/min, boys +6.3%, 1.60 to 170 l/min) whereas relative VO_2max did not change, 39.6 ml/kg/min in girls and 46.1 ml/kg/min in boys.

A similar 13 week protocol was used to compare training programs of 3 and 2 times per week in 10-11 year old children (mean ages were not reported, Mandigout et al., 2002). The first experimental group (18 boys, 18 girls) did interval training (90% HR max), continuous training (80% HR max) and a mixed training with several aerobic activities like basketball and other games 3 times per week, while the second experimental group (10 boys, 10 girls) trained in the same manner but without the mixed session only 2 times a week. All training sessions lasted one hour. A control group (15 boys, 13 girls) were not involved in extra training activities. An incremental bicycle ergometer test was used. The first experimental group of girls increased significantly both absolute and relative VO_2max by 14.6% (1.37±0.20 to 1.57±0.19 l/min) and 8.6% (38.2±4.4 to 41.5± 4.6 ml/min/kg), respectively. Boys in the first experimental group gained in absolute VO_2max by 6.4% (1.71±0.32 to 1.82±0.39 l/min) and in relative VO_2max by 5.1% (46.9±7.9 to 49.3±7.1 ml/min/kg). Children in the second experimental group made smaller gains in absolute VO_2max, +4.2% in girls (1.44 to 1.50 l/min) and +2.4% in boys (1.66 to 1.70 l/min); relative VO_2max improved only in girls, +1.2% (40.1 to 40.6 ml/kg/min) but not in boys (stable at 45.5 ml/kg/min). The control group also improved in absolute VO_2max, +6.9% in girls (1.45 to 1.55 l/min) and +1.8% in boys (1.69 to 1.72 l/min), while relative VO_2max did not change, girls 41.1 ml/kg/min and boys 46.6 ml/kg/min.

In contrast to the preceding studies which utilized a variety of activities to make training more attractive, others have utilized a more controlled training protocol (McManus et al., 1997, 2005). VO_2max of boys in continuous (n=10, 10.4±0.5 years) and interval (n=10, 10.4±0.3 years) training groups and a control group (n=15 boys, 10.5±0.4 years) were compared after 8 weeks. Both experimental groups trained 3 times per week for 20 minutes, while the control group had no training. The continuous training protocol involved 20 minutes per session on a cycle ergometer at heart rate between

160 and 170 bpm, while the interval training protocol called for 7 maximal sprints of 30 seconds each during the 20 minute session. Boys rested between sprints by cycling at low speed. After 8 weeks, both training groups increased significantly in VO_2max on an incremental bicycle ergometer test. Best results were achieved by the interval training group. Absolute VO_2max increased by 11.4% (1.76±0.20 to 1.96±0.22 l/min) and relative VO_2max increased by 11.4% (45.5±3.4 to 50.7 ±3.7 ml/min/kg). The continuous training group had smaller gains in absolute and relative VO_2max, respectively, 1.65±0.16 to 1.72±0.17 l/min (4.2%) and 47.0±6.5 to 50.7±6.9 ml/min/kg (7.9%). The control group, in contrast, improved in relative VO_2max by 1.6% (44.7 to 45.4 ml/kg/min), while absolute VO_2max remained rather stable at 1.59 l/min after 8 weeks.

The second study included 12 girls (9.3±0.5 years) who participated in a cycle ergoment training protocol 3 times per week for 20 minutes at a heart rate of 160 to 170 bpm and 11 girls (9.8±0.4) who participated in sprint running for 8 weeks. The running protocol called for maximal sprints of 10 and 30 seconds; the number of sprints increased from 3 of each duration in the first week to 6 sprints of each duration in week 8 (McManus et al., 1997). A control group had no formal training. VO_2max was assessed with aan incremental treadmill test. Both experimental groups improved significantly in absolute VO_2max, cycling group by 10% (1.30±0.19 to 1.43± 0.20 l/min) and running group by 8.4% (1.54±0.24 to 1.67±0.22), while the control group did not change in absolute VO_2max (1.49 l/min) after 8 weeks.

Also using a laboratory protocol, an experimental group (12 boys, 14 girls) trained for 12 weeks on 3 sessions per week of 30 minutes continuous (80% of HR max) cycling on an ergometer (Tolfrey et al., 1998). A control group (10 boys, 9 girls) had no additional training. Mean age of the total group was 10.5±0.7 years. An incremental cycling test was used to estimate VO_2max. The experimental group increased absolute VO_2max by 3.8% in boys (1.60 to 1.66 l/min) and 13.2% in girls (1.36 to 1.54 l/min); variance statistics were not reported. Relative VO_2max increased by 1.3% in boys (46.6 to 47.2 ml/kg/min) and 7.9% in girls (39.3 to 42.4 ml/kg/min). Although there was a trend for improved performance, the changes were not significant. The control group did not change in relative VO_2max, 44.7 ml/kg/min in girls and 50.7 ml/kg/min in boys, after 12 weeks, while absolute VO_2max increased slightly in boys, 1.62 to1.65 l/min (+1.9%) but not in girls, 1.52 l/min.

Several studies did not include a control group. To deal with this problem, subjects were followed for a period of no formal training prior to the onset of a training protocol. For example, 37 youth 11-13 years of age (24 girls, 13 boys) were followed for 12 weeks before training began; subsequently, trained for 12 weeks, 3 sessions per week on an aerobic circuit,

running and training with various ball sports (Rowland and Boyajian, 1995). Training was targeted at a heart rate between 165 and 175 bpm. Subjects were tested at the three time points with an incremental treadmill protocol. There was little change in both absolute (1.96±0.32 to 2.02±0.35, +3.6%) and relative (44.3±5.8 to 44.7±5.8 l/min/kg, +0.9%) VO_2max after 12 weeks of non-training. After 12 weeks of aerobic training absolute and relative VO_2max increased significantly to 2.24±0.38 l/min (+10.9%) and 47.6±6.4 ml/min/kg (+6.5%). Sex-specific results were not reported.

In related study (Rowland et al., 1996), 31 children (20 girls, 9 boys, 11.8±0.5 years) had a baseline period of no formal training for 13 weeks (except for formal physical education 2 times per week) which was followed by 13 weeks of aerobic training which replaced the physical education classes. Training occurred 3 times per week for 30 minutes and involved several aerobic exercises (HR 170 to 180 bpm). An incremental cycle ergometer test was used to estimate VO_2max at the three time points. Among girls absolute VO_2max increased from 1.76±0.24 to 1.81±0.28 to 1.97±0.34 across the three testing moments while relative VO_2max changed only slightly, 43.7±6.3 to 43.9±6.8 to 46.1±7.7 ml/kg/min. After 13 weeks of aerobic training, absolute and relative VO_2max improved by 8.8% and 5.0%, respectively. Corresponding values in boys at the three testing moments were, respectively, were 2.08±0.31, 2.15±0.31 and 2.29±0.30 l/min for absolute VO_2max and 45.3±9.2, 45.4±8.8 and 48.2±9.4 ml/kg/min for relative VO_2max. Improvements after 13 weeks of training approcimated 6.5% and 6.2%, respectively. A significance ($p=0.06$) for for relative VO_2max is girls and boys combined was reported.

While most studies indicate an improvement in VO_2max with training, there are exceptions. An 8 week program of interval run training of 10 and 30 second maximal sprints (12 boys, 10.1±0.3 years) and continuous cycling for 20 minutes at 160-170 bpm (13 boys, 10.1±0.2 years), 3 sessions per week resulted in no significant changes in VO_2max (Williams et al., 2000). A control group (14 boys, 10.1±0.3 years) had no training. VO_2max was measured with an treadmill incremental test. Absolute VO_2max showed a non-significant increase (1.84±0.2 to 1.91±0.3 l/min, +3.8%) while relative VO_2max decreased slightly (54.8±5.1 to 53.9±7.8 ml/min/kg, -1.6%) in the sprint interval running group. The continuous group improved, though not significantly, in both absolute (1.80±0.3 to 1.93±0.3 l/min, +7.2%) and relative (54.7±9.7 to 57.5±7.0 ml/min/kg, +5.1%) VO_2max. The control group showed a small gain in absolute VO_2max (1.92±0.2 to 1.97±0.2) l/min, +2.6%) but no change in relative VO_2max (56.4 ml/kg/min).

b) Specializing years (about 13-15 years)

Most studies of the sampling years did not use samples of not specifically trained children. investigated The influence of a 4-week training pre-season program on VO_2max was evaluated in 27 top basketball players (14.7±0.5 years) divided into control (n=7), specialized training (n=10) and mixed training (n=10) groups (Bogdanis et al., 2007). The control group did not follow any training. The specialized group followed normal basketball training of variable intensities while the mixed group combined circuit training (20% of time) normal basketball training. Training sessions of 110-120 minutes occurred 5 days per week. An incremental treadmill test was used. Both experimental groups showed significant improvement in relative VO_2max; absolute values were not reported. Improvements were 4.6% in both groups, 52.3±1. to 54.7±0.7 ml/kg/min for the specialized and 52.5±1.3 to 54.9±1.0 ml/kg/min for the mixed training protocols. The control group did not improve (49.8 ml/kg/min).

Two other studies in specialization age range did not observe significant training effects. Stoedefalke et al. (2000) found no significant increase in VO2-max measured during an incremental treadmill test after 20 weeks of training. In this experiment 38 girls were involved, Twenty girls (13.6±0.3 years) completed a training program of 3 sessions per week for 20 weeks (Stoedefalke et al., 2000). Training sessions were 20 minutes at 80% HR max and consisted of running, cycling, rowing and dancing. A group of 18 girls (13.7±0.2 years) served as a control and continued normal daily activities. Absolute VO_2max increased in the experimental group by 3.1%, 2.25±0.30 to 2.32±0.28 l/min, while the control group improved by 2.5%, 2.39±0.36 to 2.45±0.30 l/min; relative values were not reported.

In a co-twin control study of 9 male monozygotic twins 11-14 years, one twin did high speed running for 1.0-1.5 hours per session 3 days per week for 26 weeks while the other twin continued normal daily activities (Danis et al., 2002). VO_2max was tested on 3 occasions with an incremental treadmill test at the beginning, after 3 months and at the end 26 weeks. Both experimental and control twins improved in absolute and relative VO_2max. Mid-way in the program (13 weeks), the trained twins improved in both absolute (2.08±0.43 to 2.23±0.45 l/min, +7.2%) and relative (52.1±3.6 to 53.9±3.8 ml/min/kg, +3.5%) VO_2max, while the control twins increased in absolute but decreased in relative VO_2max. After 26 weeks, absolute VO_2max reached 2.37±0.45 l/min and 57.5±3.6 ml/min/kg in the experimental twins, reflecting further improvements of 6.3% and 6.7% in absolute and relative VO_2max, respectively. The overall improvement over 26 weeks was thus 13.9% in absolute and 10.4% in relative VO_2max. After 13 weeks, the control twins increased in absolute (2.10±0.41 to 2.18±0.43 l/min, +3.8%) but

decreased in relative VO_2max (54.0 ± 3.9 to 52.6 ± 3.8 ml/min/kg, -2.6%). Over the next 13 weeks, absolute VO_2max increased to 2.32± 0.47 l/min (+6.4%) and relative VO_2max increased to 55.4± 3.3 ml/min/kg (+5.3%) in the control twins. The control twins increased by 10.5% in absolute and by 2.6% in relative VO_2max over the 26 week interval. Mid-way during the program, improvements in VO_2max between experimental and control twins were significant but after 26 weeks they were not.

c) Investment years (about 16-18 years)

Eliakim et al. (1996) also investigated effects of training in 15-17 (no means were reported) years old girls. A summer school setting was used to evaluate the influence of an aerobic training program on girls 15-17 years of age (Eliakim et al., 1996). A sample of 44 girls were randomly dived into experimental and control groups. The former had 5, two hour training sessions per week for 5 weeks; sessions included 50% running, 25% team sports and 25% dancing (although no further specifics were indicated). Control subjects had no special activities other than a computer education program. An incremental cycle test was used. Experimental subjects significantly improved in absolute VO_2max by 12.1%, 1.48±0.6 to 1.63±0.5 l/min, whereas control subjects showed no change (1.57 l/min). Relative values were not reported.

VO_2max was measured before and after a competitive season (13 weeks) in a team of 9 male cross country runners (15.9**±**1.0 years, 4.2**±**2.1 years of experience) using an incremental test on a running ergometer (Plank et al., 2005). Training consisted of 6 sessions a week of about 1 hour duration using different running activities (continuous and interval running, competitive races. Both absolute and relative VO_2max increased significantly after 13 weeks, 3.73±0.64 to 3.98±0.62 l/min (+6.7%) and 61.6±3.5 to 65.3±2.9 ml/min/kg (+6.0%). No control group was included.

A sample of 16 late adolescent-young adults (4 boys, 12 girls,19.5±3.2 years) was included in a study comparing measurements of the CardioCoach with laboratory equipment (Vehrs et al., 2007). The focus was not training effects and no control group was included. Participants followed a 14 week program 3-5 sessions per week of 20-40 minutes of aerobic exercise at 65-85% HR max. Maximal graded exercise treadmill test were done before, after 7 weeks and at the end of the program. Relative VO_2max improved significantly from 44.4±5.0 to 46.0±5.2 (7 weeks) to 47.8±5.6 ml/min/kg (14 weeks), an overall improvement of 7.7%. Absolute VO_2max and sex differences were not reported.

Tabel 1. Results of studies without a training program (studies are listed by first author only although all papers have multiple authors)

	Training status	n	Age (yrs)	VO_2max (l/min)		VO_2max (ml/min/kg)	
				Boys	Girls	Boys	Girls
Gursel 2004	U	90	5-6	*		35.2	36.7
			7-8			38.1	37.4
			9-10			43.8	39.0
			11-12			46.3	41.4
			13			48.0	40.5
Dencker 2006	U	228	10	*		42.0	36.0
Dencker 2007	U	248	10	1.42	1.21	41.4	35.8
Vinet 2003	U	35	11	1.80	1.42	47.9	41.7
Rowland 2000	U	25	12	1.98	1.84	47.2	40.4
Pate 2007	U	3287	12-13	*		44.6	39.7
			14-15			47.1	38.3
			16-17			46.9	38.9
			18-19			47.6	37.5
Impertone 2006	U	1783	15	*		46.6	38.8
Eisenmann 2001	T	124	9-10	1.94	1.81	62.7	56.3
			11	2.11	1.95	63.6	57.9
			12	2.47	2.28	63.3	57.1
			13	2.63	2.44	60.8	54.8
			14	3.07	2.69	63.5	56.9
			15	3.64	2.84	62.7	56.2
			16	3.88	2.85	64.8	54.3
			17	4.25	2.89	67.5	51.8
			18	4.39	-	67.3	-
Noury 2004	T	24	9-11	1.79	1.31	51.4	40.2
Tolfrey 2006	T	15	12	2.23	-	*	
Cleuziou 2002	T&U	20	13	*		U: 38.7 T: 52.4	
Cubero 2000	T	64	15	*		53.0 can.	-
			16			57.0 cycl.	
			17			48.0 soc.	
Thevenet 2007	T	8	16	*		56.9	-

T: trained subjects, U: untrained subjects, *: no results, can: canoeist, cycl: cycling, soc: soccer.

Samples of 75 male and 49 female elite distance runners 9-19 years were followed in a mixed-longitudinal design (Eisenmann et al., 2001). The age range thus spans the three sport development stages used in this review. The subjects ran about 35 km a week or more and some were followed up to 5 years. VO_2max was measured annually with an incremental treadmill test. The mixed-longitudinal data were pooled yielding observations for 139 males and 105 females. Over the duration of the study, absolute VO_2max of the runners

increased significantly with age from 1.93±0.22 l/min at 9 years to 4.39±0.66 l/min at 18 years in boys and from 1.81±0.18 to 2.89±0.39 l/min in girls over the same ages. Relative VO_2max remained relatively stable (~62.5 ml/kg/min) between 9 and 15 years in male runners, but increased >67.0 ml/kg/min between 16 and 19 years (investment years). Nevertheless, the improvement was not significant. Relative VO_2max was also stable in female runners (~56.0 ml/kg/min) across the sampling and specializing years but declined to ~52.0 ml/kg/min in the investment years; the change, however, was not significant.

Table 2. Characteristics of training studies (studies are listed by first author only although all papers have multiple authors)

	Training status	Mean age (yrs), n	Length (wks), # sessions per week	Content, Intensity, Training time (min)	VO_2max Before Training (l/min)
Sampling years					
Eliakim 2001	U	9.1 40	5 10	Run + Ball, *, 90	EG G: * CG G: *
McManus 1997	U	9.5 30	8 3	Int/Con, Max/165bpm, 20	ITG G: 1.54 CTG G: 1.30 CG G: 1.49
Baquet 2002	U	9.7 53	7 2	Int, *, 30	EG B&G: 1.54 CG B&G: 1.62
Nourry 2005	U	10.0 18	8 2	Int, *, 30	EG B&G: * CG B&G: *
Williams 2000	U	10.1 39	8 3	Int/Con, Max/165bpm, 20	ITG B: 1.84 CTG B: 1.80 CG B: 1.92
Mandigout 2002	U	10.5 19	13 3	Int, Con, Mxd, 90%, 80%, 60	EG B&G: * CG B&G: *
McManus 2005	U	10.5 35	8 3	Int/Con, Max/165bpm, 20	ITG B: 1.76 CTG B: 1.65 CG B: 1.59
Tolfrey 1998	U	10.5 45	12 3	Con, 80%, 30	EG G: 1.36 EG B: 1.66 CG G: 1.52 CG B: 1.62

(continues)

	VO_2max after training (l/min)	Increase absolute VO_2max	VO_2max before training (ml /kg/min)	VO_2max after training (ml /kg/min)	Increase relative VO_2max
Sampling years					
Eliakim 2001	1.45	*	*	45.0	9,5%
	*			*	
McManus 1997	1.67	8.4%	*	*	*
	1.43	10.0%			
	1.46	-			
Baquet 2002	1.68	9.1%	43.9	47.5	8.2%
	1.62	-	46.2	45.3	-
Nourry 2005	*	*	37.4	43.2	15.5%
			36.8	36.6	-
Williams 2000	1.91	3.8%	54.8	53.9	-
	1.93	9.3%	54.7	57.5	5.1%
	1.97	2.6%	56.4	56.7	-
Mandigout 2002	*	*	41.3	47.9	16.0%
			45.9	45.1	-
McManus 2005	1.96	11.4%	47,0	50,7	7,9%
	1.72	4.2%	45,5	50,7	11,4%
	1.57	-	44.7	45.4	1.6%
Tolfrey 1998	1.54	13.2%	39.9	42.4	7.9%
	1.66	3.8%	46.6	47.2	1.3%
	1.52	-	44.7	43.0	-
	1.65	1.9%	50.7	50.3	-

(continues)

	Training status	Mean age (yrs), n	Length (wks), # sessions per week	Content, Intensity, training time (min)	VO_2max Before Training (l/min)
Mandigout 2001	U	10.5 85	13 3	Int, Con, Mxd, 90%, 80%, 60	EG G 1.30 EG B 1.70 CG G: 1.40 CG B: 1.60
Obert 2003	U	10.6 35	13 3	Int, Con, 90%, 80%, 60	*
Mandigout 2002	U	10-11 84	13 3&2	Int, Con, (Mxd), 90%, 80%, 60	EG1 G: 1.37 EG2 G: 1.44 EG1 B: 1.71 EG2 B: 1.66 CG G: 1.45 CG B: 1.69
Rowland 1996	U	11.8 29	13 3	Mxd, 175bpm, 30	G: 1.81 B: 2.08 CG: -
Rowland 1995	U	11-13 37	12 3	Mxd, 170bpm, 30	EG B&G: 2.02 CG: -
Obert 1996	T	9.3 14	52 10	Mxd swim tr, *, 120	EG G: 0.79 CG G: 0.69
Vamvakoudis 2007	T	11.5 38	78 6	Mxd basket tr, *, 90	EG B: 2.31 CG B: 2.11

(continues)

	VO_2max after training (l/min)	VO_2max absolute VO2-max	VO_2max before Training (ml/min/kg)	VO_2max after training (ml/min/kg)	Increase Relative VO_2max
Mandigout 2001	1.57	20.7%	38.6	41.9	8.5%
	1.84	8.2%	47.2	49.2	4.2%
	1.50	7.1%	39.6	39.5	-
	1.70	6.3%	46.1	45.5	-
Obert 2003	*	*	EG G: 40.9	44.2	8.1%
			EG B: 44.1	50.9	15.4%
			CG G: 42.4	42.6	-
			CG B: 51.5	50.3	-
Mandigout 2002	1.57	14.6%	38.2	41.5	8.6%
	1.50	4.2%	40.1	40.6	1.2%
	1.82	6.4%	46.9	49.3	5.1%
	1.70	2.4%	45.5	45.2	-
	1.55	6.9%	41.1	40.1	-
	1.72	1.8%	46.6	45.6	-
Rowland 1996	1.97	8.8%	43.9	46.1	5.0%
	2.29	6.5%	45.4	48.2	6.2%
Rowland 1995	2.24	10.9	44.7	47.6	6.5%
Obert 1996	1.10	39.2%	26.2	33.8	29%
	0.79	14.5%	24.7	24.9	-
Vamvakoudis 2007	3.11	34.6%	51.4	55.8	8.6%
	2.62	24.2%	42.2	45.6	8.1%

(continues)

	Training status	Mean age (yrs), n	Length (wks), # sessions per week	Content, Intensity, training time (min)	VO_2max Before Training (l/min)
Specializing years					
Danis 2002	U	11-14	26	Run,	EG B: 2.08
		18	3	*, 60	CG B: 2.10
Stoedefalke 2000	U	13-14	20	Mxd,	EG G: 2.25
		38	3	80%, 20	CG G: 2.39
Bogdanis 2007	T	14.7	4	Mxd basket,	*
		27	5	*, 110	
Investment years					
Eliakim 1996	U	15-17	5	Mxd,	EG G: 1.48
		44	5	*, 120	CG G: 1.57
Vehrs 2007	U	19.5	14	Mxd,	*
		16	3-5	75%, 30	
Plank 2005	T	15.9	13	Run,	EG B: 3.73
		9	5	mxd, 60	CG: -

(continues)

	VO_2max after training (l/min)	Increase absolute VO2-max	VO_2max before Training (ml/min/kg)	VO_2max after training (ml/min/kg)	Increase Relative VO_2max
Specializing years					
Danis 2002	2.37	13.9%	52.1	57.5	10.4%
	2.32	10.5%	54.0	55.4	2.6%
Stoedefalke 2000	2.32	3.1%	*	*	*
	2.45	2.5%			
Bogdanis 2007	*	*	EG1 B: 52.3	54.7	4.6%
			EG2 B: 52.5	54.9	4.6%
			CG B: 49.8	49.4	-
Investment years					
Eliakim 1996	1.63	12.1%	*	*	*
	*	-			
Vehrs 2007	*	*	EG B&G: 44.4	47.8	7.7%
			CG: -		
Plank 2005	3.98	6.7%	61.6	65.3	6.0%

*No values reported, G: values for girls, B: values for boys, B+G: values for boys and girls separated, B&G: values of boys and girls not separated, ITG: Interval Training Group, CTG: Continuous Training Group, EG: Experimental Group, CG: Control Group, T: trained subjects, U: untrained subjects, Mxd: mixed training types, Run: running training, Int: interval training, Con: continuous training

DISCUSSION

Changes in absolute VO_2max associated with training vary from 2.4% to 39.2% with a slightly higher mean increase girls (±12,5%) than in boys (±10%). All studies except one (Williams et al., 2000) also show at least small increments in relative VO_2max with training and the mean increase was higher in girls (±10%) than in boys (±6.5%).

One of the goals of this study was to evaluate variation in trainability during three three sport development stages proposed by Côté and Hay (2002). Accordingly, the focus shifts from sampling (~6-12 years) through specializing (~13-15 years) into investment years (~16+ years) on a continuum from deliberate play to deliberate practice. The goal of deliberate practice is to improve an aspect of performance. In the context of the present review, the performance focus is VO_2max. Most studies in the last 15 years concerned the trainability of VO_2max in the age range spanning the sampling years, while few studies considered the specializing (Bogdanis et al., 2007; Danis et al., 2002; Stoedefalke et al., 2000) and investment years (Eliakim et al., 1996; Plank et al., 2005; Vehrs et al., 2007) years. One study was spanned all three sport development stages (Eisenmann et al., 2001).

Figure 1a shows absolute VO_2max reported in all studies reviewed. Values from studies without a training program and at the beginning of a training program from the studies with an intervention are used to form a

baseline that probably reflect normal growth of VO_2max. Absolute VO_2max increases almost linearly to about 15 years after which girls appear to reach a plateau and boys continue to improve. This is consistent with earlier discussions (Krahenbuhl et al., 1985; Bar-Or, 1986; Rowland, 1996; Armstrong et al., 2000). Trained children and adolescents show higher values than untrained peers of both sexes, but there appears to be no difference in the manner of increase in VO_2max across age. This implies that starting training at younger age (sampling years) does not temper an increase in VO_2max at older ages (specializing and investment years). It is not possible, however, to state that starting training during the sampling years will give an advantage for the other stages and adulthood. The 10-year rule (Ericsson et al., 1993), however, proposes that deliberate practice is necessary to reach elite level so that starting at a younger age should have an advantage compared to starting at later age.

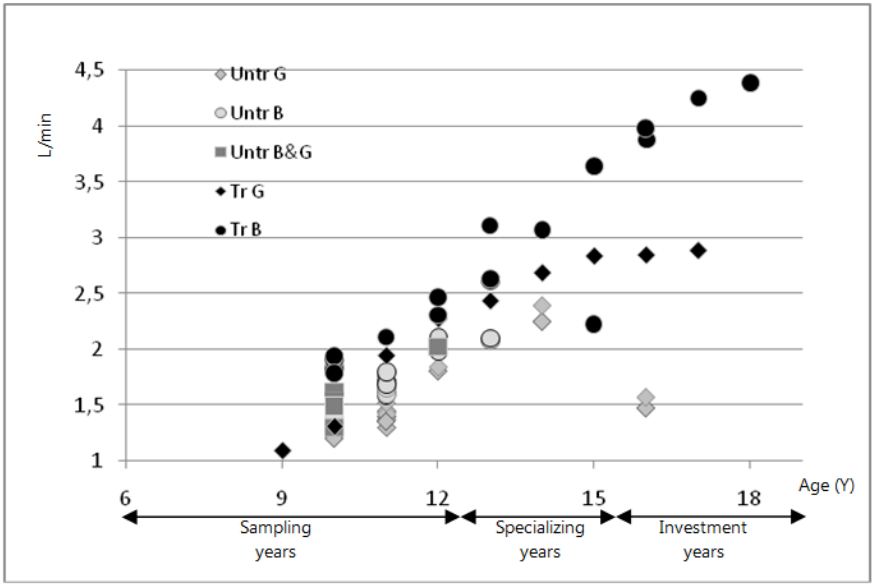

Figure 1a. Absolute VO_2max in l/min by age. Legend: [Untr] untrained; [Tr] trained; [G] girls; [B] boys, [B&G] boys&girls

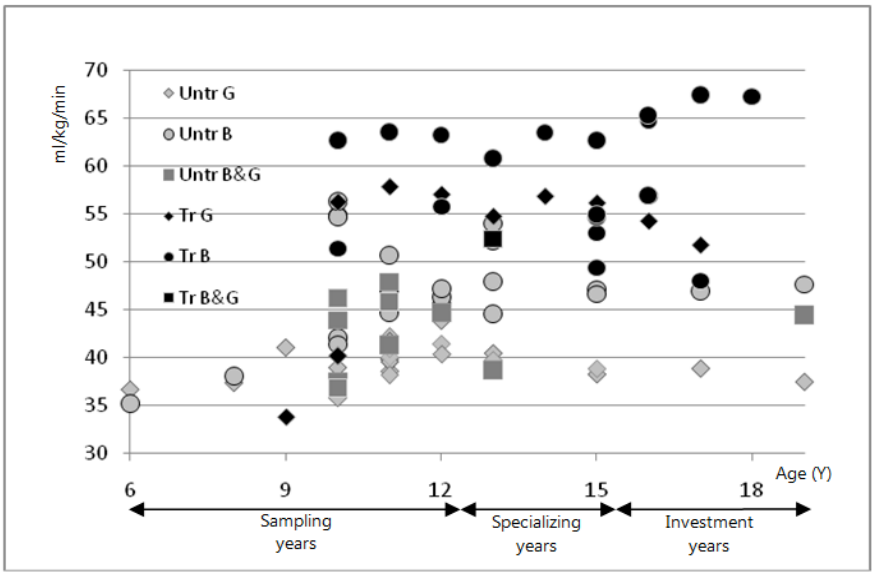

Figure 1b. Relative VO_2max in ml/kg/min by age. Legend: [Untr] untrained; [Tr] trained; [G] girls; [B] boys, [B&G] boys&girls

Figure 1b shows corresponding values for relative VO_2max. In general, trained children and adolescents have higher values compared to untrained peers. Only two results for trained girls were lower than expected. One study using a swim ergometer to measure VO_2max (Obert et al., 1996), while use of only upper body musculature gives lower results than use of lower body musculature (Al-Hazzaa et al., 1998). Relative VO_2max seems to improve during the sampling years but tends to remain stable during the subsequent stages in both sexes. This is not totally consistent with the literature (Krahenbuhl et al., 1985; Bar-Or, 1986; Rowland, 1996) which shows a decline in relative value in girls after about of 10 years of age. Although trained youth have higher values than the untrained, it appears to be difficult to improve relative VO_2max in trained children and adolescents. Limited data for the investment years show a slight increase in males but a small decrease in females. Hence, generalizations are not warranted.

To show an influence of training on improvement in VO_2max it is necessary to partition observations attributed to training from normal growth and maturation. Figures 2a and 2b show differences between experimental and control groups for all studies. Experimental groups trained 2 to 10 times per week for durations of 20 to 120 minutes over periods of 4 to 78 weeks. Improvements are divided into four categories; no improvement (less than 1%), low improvement (1-5%), moderate improvement (6-10%), and high

improvement (>10%). For both absolute and relative VO_2max 'no' improvement is observed largely within control groups. Only one experimental group shows 'no' improvement in relative VO_2max, while all experimental groups show at least low improvement in absolute VO_2max. The observation of 'no' improvement in relative VO_2max is consistent with a stable pattern during childhood and adolescence. While absolute VO_2max is more liable to growth and maturational effects, it is not surprising that some control groups show 'moderate' and even 'high' improvements. These results were found in studies of longer duration. Nevertheless, experimental groups showed higher improvements in absolute VO_2max in these studies that exceed the effects of growth and maturation. Most experimental groups show moderate and high improvement for both absolute and relative VO_2max.

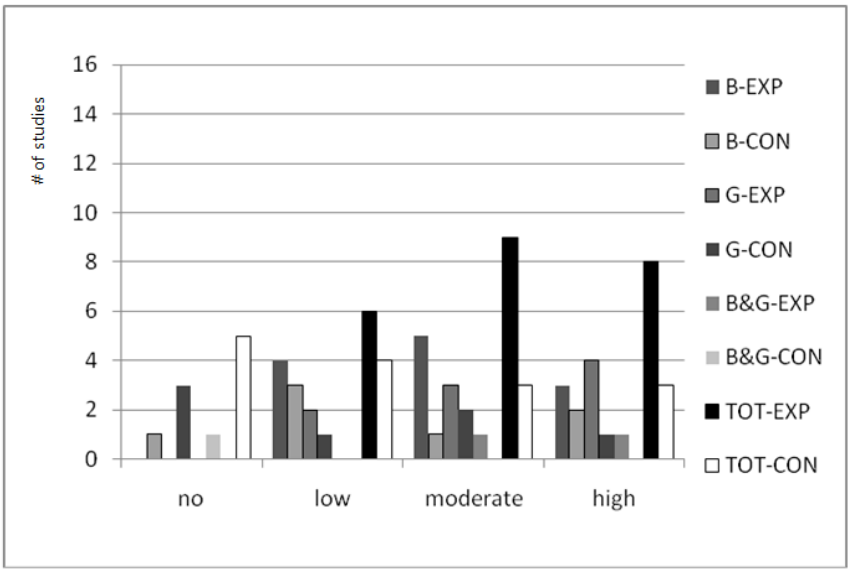

Figure 2a. Number of studies for each category of improvement of absolute VO_2max. Legend: [B] boys; [G] girls; [B&G] boys&girls; [Exp] experimental group; [Con] control group; [Tot] total

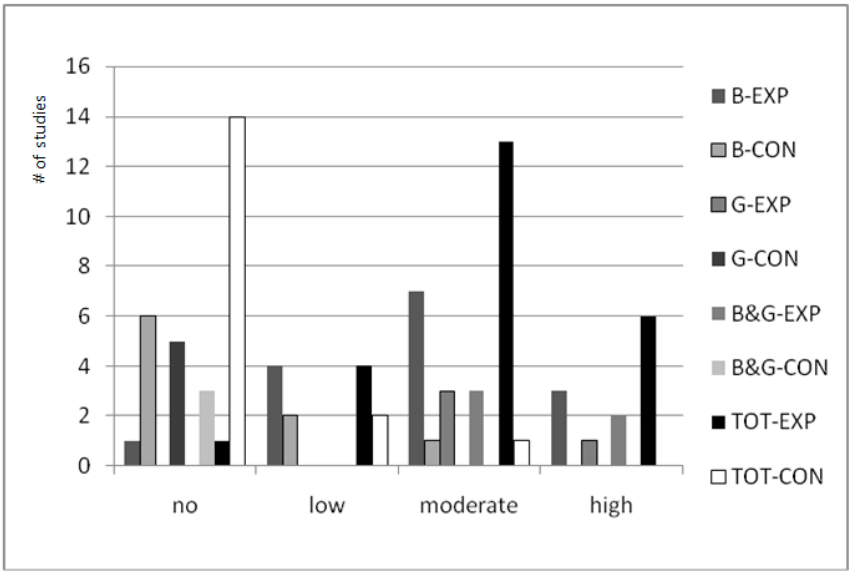

Figure 2b-number of studies for each category of improvement of relative VO_2max. Legend: [B] boys; [G] girls; [B&G] boys&girls; [Exp] experimental group; [Con] control group; [Tot] total.

Figures 3a and 3b show relative improvement (%) in VO_2max associated with training. During the sampling years improvements in absolute VO_2max are in a similar range for both trained and untrained children (3% to 20%). Only two studies reported improvements >30% in absolute VO_2max (Obert et al., 1996; Vamvakoudis et al., 2007). These studies spanned 52 and 78 weeks so that the larger improvements were due in part to growth and maturation since control groups showed high improvements, 14.5% and 24.2%, over the same periods. Improvements for trained youth tend to be lower during the specializing and investment years than during the sampling years though data are too limited for generalization.

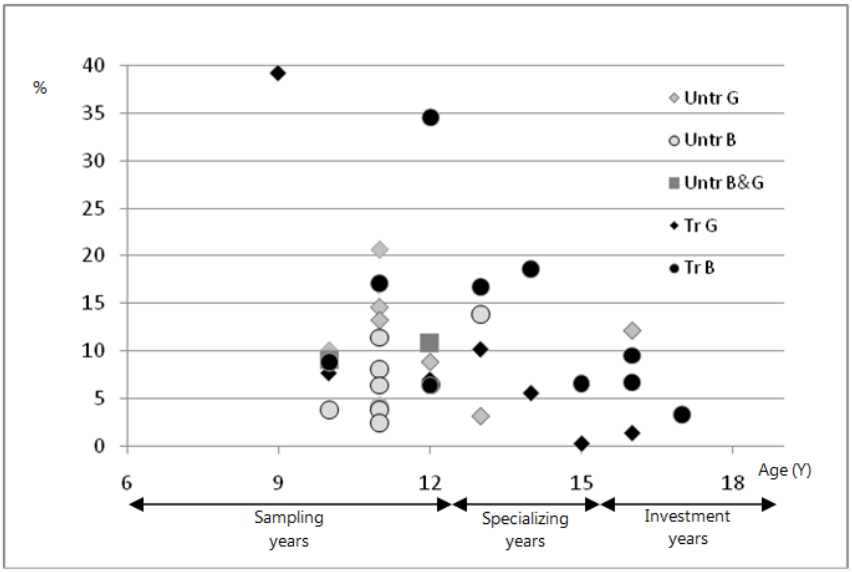

Figure 3a. Percentage improvement of absolute VO_2max due to training. Legend: [Untr] untrained; [Tr] trained; [G] girls; [B] boys; [B&G] boys&grirls.

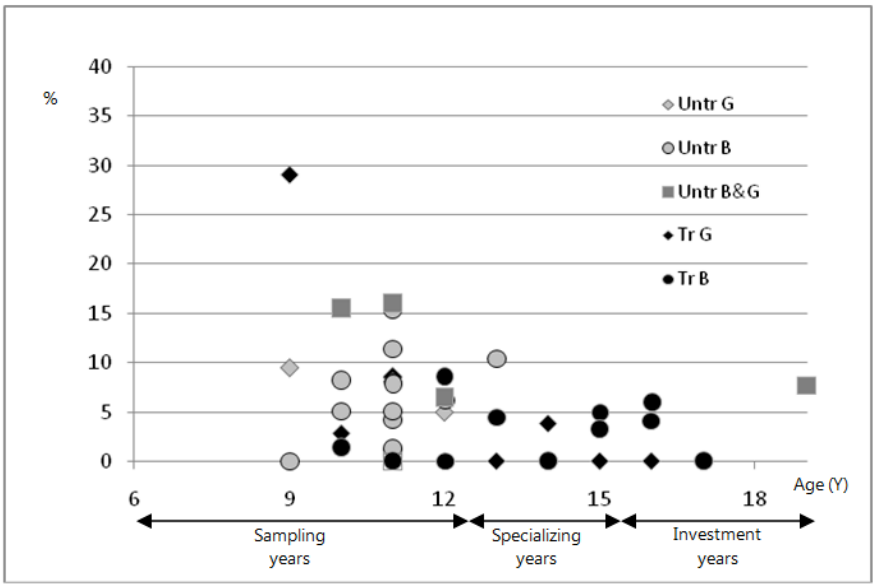

Figure 3b. Percentage improvement of relative VO_2max due to training. Legend: [Untr] untrained; [Tr] trained; [G] girls; [B] boys; [B&G] boys&grirls.

A training program of 7 weeks with 3 sessions perweek seems sufficient to improve VO_2max. Longer training periods do not show consistently better results, especially for relative VO_2max. Although highest improvements of absolute VO_2max were noted in studies with training periods >26 weeks, it is difficult to partition training from changes associated with normal growth and maturation.

More than 3 training sessions a week does not show consistently better results, whereas two sessions per week seem appear to be insufficient to improve VO_2max. Although two studies (Baquet et al., 2002; Nourry et al., 2005) used two sessions per week, the sessions were added to the normal physical education classes. In most studies training replaced at least one physical education class. With only two sessions a week, time between sessions seems to be too long for improvement to occur. This is consistent with training principles that a new impulse should occur close enought in time to bring about an effect.

The studies considered differed in training intensity and duration so that it is almost impossible to conclude which intensity is most effective. Studies generally used different training protocols during a week. One session usually consisted of interval (maximal sprints) training and another of continuous (80% of HR max or 160-180 bpm) training, while a third session included mixed activities such as ball sports and dancing. The few studies that compared interval training with continuous training showed no consistent results. Accordingly, it is not possible to conclude if one type of training is more effective than another to improve VO_2max in children and adolescents, but heart rate should be at least 160 bpm. It is also difficult to draw a conclusion on an effective training duration. Training sessions in the studies varied between 20 minutes and 2 hours. Longer sessions did not show higher improvements than shorter sessions. Moreover, training sessions of 20 minutes appear effective in improving VO_2max.

Although some results show reasonable consistency, the relatively small number of studies in combination with variation in sampling, numbers of subjects, design and protocols limits generalization. It is likely that training studies would not attract overweight and obese youth. Another confounder is failure to control for pubertal status and timing of the adolescent growth spurt. Absolute VO_2max shows its own growth spurt that occurs, on average, coincident with the growth spurt in height in both sexes (Malina et al., 2004). More comprehensive research designs are needed to better understand the influence of systematic training on growth of VO_2max at different ages during childhood and adolescence.

REFERENCES

Al-Hazzaa HM, Al-Refaee SA, Sulaiman MA (1998) Cardiorespiratory responses of trained boys to treadmill and arm ergometry: Effect of training specificity. *Pediatric Exercise Science* 10: 264-276.

Armstrong N & Welsman JR (2000) Development of aerobic fitness during childhood and adolescence. *Pediatric Exercise Science* 12: 128-149.

Baquet G, Berthoin S, Dupont G, Blondel N, Fabre C, Van Praagh E (2002) Effects of high intensity intermittent training on peak VO2 in prepubertal children. *International Journal of Sport Medicine* 23: 439-444.

Baquet G, Van Praagh E, Berthoin S (2003) Endurance training and aerobic fitness in young people. *Sports Medicine* 15: 1127-1143.

Bar-Or O (1986) Pathophysiological factors which limit the exercise capacity of the sick child. *Medicine and Science in Sports and Exercise* 18: 276-282.

Bogdanis GC, Ziagos V, Anastasiadis M, Maridaki M (2007) Effects of two different short-term training programs on the physical and technical abilities of adolescent basketball players. *Journal of Science and Medicine in Sport* 10: 79-88.

Bouchard C, Malina RM, Perusse L (1997) Genetics of Physical Fitness and Performance. Champaign, IL: Human Kinetics.

Cleuziou C, Lecoq AM, Candau R, Courteix D, Guenon P, Obert P (2002) Kinetics of oxygen uptake at the onset of moderate and heavy exercise in trained and untrained prepubertal children. *Science and Sports* 17: 291-296.

Cote J, Hay J (2002) Children's involvement in sport: A developmental perspective. In JM Silva, D Stevens (Eds), Psychological foundations of sport, 2nd edition. Boston: Merill, pp 484-502.

Cubero GI, Batalla A, Reguero JJR, Barriales R, Gonzales V, De la Iglesia JL, Terrados N (2000) Left ventricular mass index and sports: the influence of different sports activities and arterial blood pressure. *International Journal of Cardiology* 75: 261-265

Danis A, Kyriazis Y, Klissouras V (2003) The effect of training in male prepubertal and pubertal monozygotic twins. *European Journal of Applied Physiology* 89: 309-318.

Dencker M, Thorsson O, Karlsson MK, Lindén C, Svenson J, Wollmer P, Andersen LB (2006) Daily physical activity and its relation to aerobic fitness in children aged 8-11 years. *European Journal of Applied Physiology* 96: 587-592.

Dencker M, Thorsson O, Karlsson MK, Lindén C, Eiberg S, Wollmer P, Andersen LB (2007) Gender differences and determinants of aerobic fitness in children aged 8-11 years. *European Journal of Applied Physiology* 99: 19-26.

Eisenmann JC, Pivarnik JM, Malina RM (2001) Scaling peak Vo2 to body mass in young male and female distance runners. *Journal of Applied Physiology* 90: 2172-2180.

Eliakim A, Barstow TJ, Brasel JA, Ajie H, Lee PWN, Renslo R, Berman N, Cooper DM (1996) Effect of exercise training on energy expenditure, muscle volume, and maximal oxygen uptake in female adolescents. *Journal of Pediatrics* 129: 537-543.

Eliakim A, Scheett T, Brasel JA, Allmendinger N, Cooper DM (2001) Training, muscle volume, and energy expenditure in nonobese American girls. *Journal of Applied Physiology* 90: 35-44.

Ericsson KA (2003) Development of elite performance and deliberate practice. An update from the perspective of the expert performance approach. In JL Starkes, KA Ericsson (Eds), *Expert Performance in Sports.* Champaign, IL: Human Kinetics, pp 50-87.

Ericsson KA, Krampe RT, Tesch-Römer C (1993) The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, 363-406.

Gilliam TB, Freedson PS (1980) Effects of a 12 week school physical fitness program on peak VO2-max, body composition, and blood lipids in 7 to 9 year old children. *International Journal of Sports Medicine* 1: 73-78.

Gursel Y, Sonel B, Gok H, Yalcin P (2004) The peak oxygen uptake of healthy Turkish children with reference to age and sex: a pilot study. *Turkish Journal of Pediatrics*, 46: 38-43.

Imperatore G, Cheng YLJ, Williams DE, Fulton J, Gregg EW (2006) Physical activity, cardiovascular fitness, and insulin sensitivity among US adolescents - The National Health and Nutrition Examination Survey, 1999-2002. *Diabetes Care* 29: 1567-1572.

Krahenbuhl GS, Skinner JS, Kohrt WM (1985). Developmental aspects of maximal aerobic power in children. *Exercise and Sport Science* 13: 503-538.

Malina RM, Bouchard C, Bar-Or O (2004) Growth, Maturation, and Physical Activity, 2nd edition. Champaign, IL: Human Kinetics.

Mandigout S, Lecoq AM, Courteix D, Guenon P, Obert P (2001) Effect of gender in response to an aerobic training programme in prepubertal children. *Acta Paediatrica* 90: 9-15.

Mandigout S, Melin A, Lecoq AM, Courteix D, Obert P (2002) Effect of two aerobic training regimens on the cardiorespiratory response of prepubertal boys and girls. *Acta Paediatrica* 91: 403-408.

Mandigout S, Melin A, Fauchier L, N'Guyen LD, Courteix D, Obert P (2002) Physical training increases heart rate variability in healthy prepubertal children. *European Journal of Clinical Investigation*, 32: 479-487

McManus AM, Armstrong N, Williams CA (1997) Effect of training on the aerobic power and anaerobic performance of prepubertal girls. *Acta Paediatrica* 86: 456-459.

McManus AM, Cheng CH, Leung MP, Yung TC, Macfarlane DJ (2005) Improving aerobic power in primary school boys: A comparison of continuous and interval training. *International Journal of Sport Medicine* 26: 781-786.

Nottin S, Vinet A, Stecken F, N'Guyen LD, Ounissi F, Lecoq AM, Obert P (2002) Central and peripheral cardiovascular adaptations to exercise in endurance-trained children. *Acta Physiologica Scandinavica* 175: 85-92.

Nourry C, Fabre C, Bart F, Grosbois JM, Berthoin S, Mucci P (2004) Evidence of exercise-induced arterial hypoxemia in prepubescent trained children. *Pediatric Research* 55: 647-681.

Nourry C, Deruelle F, Guinhouya C, Baquet G, Fabre C, Bart F, Berthoin S, Mucci P (2005) High-intensity intermittent running training improves pulmonary function and alters exercise breathing pattern in children. *European Journal of Applied Physiology* 94: 415-423.

Obert P, Mandigouts S, Nottin S, Vinet A, N'Guyen LD, Lecoq AM (2003) Cardiovascular responses to endurance training in children: effect of gender. *European Journal of Clinical Investigation* 33: 199-208.

Obert P, Courteix D, Lecoq AM, Guenon P (1996) Effect of long-term intense swimming training on the upper body peak oxygen uptake of prepubertal girls. *European Journal of Applied Physiology* 73: 136-143.

Pate RR, Wang CY, Dowda M, Farrell SW, O'Neill JR (2006) Cardiorespiratory fitness levels among US youth 12 to 19 years of age - Findings from the 1999-2002

National Health and Nutrition Examination Survey. *Archives of Pediatrics and Adolescents Medicine* 160: 1005-1012.
Plank DM, Hipp MJ, Mahon AD. (2005) Aerobic exercise adaptations in trained adolescent runners following a season of cross-country training. *Research in Sports Medicine* 13: 273-286.
Powers SK, Howley ET (2003) Exercise physiology, theory and applications to fitness and performance, 5th edition. New York: McGraw-Hill.
Rowland T, Goff D, Martel L, Ferrone L (2000) Influence of cardiac functional capacity on gender differences in maximal oxygen uptake in children. *Chest* 117: 629-635
Rowland TW (1993) Does peak VO2 reflect VO2-max in children – evidence from supramaximal testing, *Medicine and Science in Sports and Exercise* 25: 689-693
Rowland TW (1996) Developmental exercise physiology. Human Kinetics., Champaign, Illinois.
Rowland TW, Boyajian A (1995) Aerobic response to endurance exercise training in children. *Pediatrics* 96: 654-658.
Rowland TW, Martel P, Vanderburgh T, Charkoudian N (1996) The influence of short-term aerobic training on blood lipids in healthy 10-12 year old children. *International Journal of Sports Medicine* 17: 487-492.
Stansky AW, Mickelson RJ, Van Fleet C (1979) Effects of swimming training regimen on hematological, cardiorespiratory, and body composition changes in young females. *Journal of Sports Medicine and Physical Fitness* 19: 347-354.
Stoedefalke K, Armstrong N, Kirby BJ, Welsman JR (2000) Effect of training on peak oxygen uptake and blood lipids in 13 to 14-year-old girls. *Acta Paediatrica* 89: 1290-1294.
Thevenet D, Tardieu-Berger M, Berthoin S, Prioux J (2007) Influence of recovery mode (passive vs. active) on time spent at maximal oxygen uptake during an intermittent session in young and endurance-trained athletes. *European Journal of Applied Physiology* 99: 133-142.
Thompson AM, Baxter-Jones ADG (2002) Endurance training in young female athletes. *Sports Medicine and Arthroscopy Review* 10: 33-41.
Tolfrey K, Campbell IG, Batterham AM (1998) Aerobic trainability of prepubertal boys and girls. *Pediatric Exercise Science*10: 248-263.
Tolfrey K, Barker A, Thom JM, Morse CI, Narici MV, Batterham AM (2006) Scaling of maximal oxygen uptake by lower leg muscle volume in boys and men. *Journal of Applied Physiology,* 100: 1851-1856.
Vamvakoudis E, Vrabas IS, Galazoulas C, Stefanidis P, Metaxas TI, Mandroukas K (2007). Effects of basketball training on maximal oxygen uptake, muscle strength, and joint mobility in young basketball players. *Journal of Strength and Conditioning Research* 21: 930-936
Vehrs PR, Keller DM, George JD, Hager RL, Fellingham GW (2007) Monitoring VO2-max during fourteen weeks of endurance training using the CardioCoach. *Journal of Strength and Conditioning Research* 21: 62-66.
Vinet A, Mandigout W, Nottin W, N'Guyen LD, Lecoq AM, Courteix D, Obert P (2003) Influence of body composition, hemoglobin concentration, and cardiac size and function of gender differences in maximal oxygen uptake in prepubertal children. *Chest* 124: 1494-1499.
Williams CA, Armstrong N, Powell J (2000) Aerobic responses of prepubertal boys to two modes of training. *British Journal of Sports Medicine* 34 : 168-173.

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CHAPTER 11: PHYSIOLOGICAL DEMANDS OF SOCCER - implications for training youth

Thomas Reilly [†]

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.

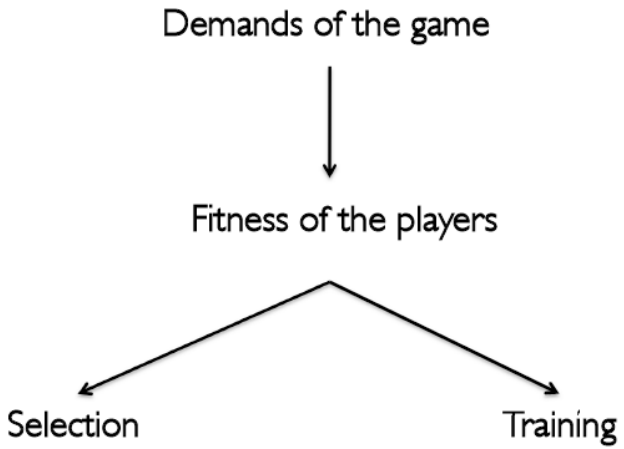

Figure 1. An ergonomics approach to analysing match demands.

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.

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.

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.

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 $\dot{V}O_{2\,max}$ 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.

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.

Table 1. Physiological characteristics of elite and sub-elite soccer players (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		
$\dot{V}O_{2\,max}$ ($ml.kg^{-1}.min^{-1}$)	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]

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 $\dot{V}O_{2\,max}$ 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.

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. 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.

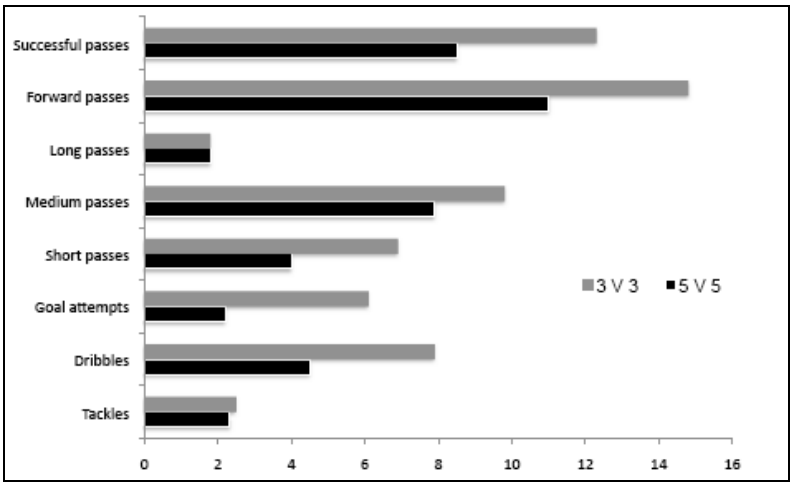

Figure 2. Frequencies of player involvement during 5 vs 5 and 3 vs 3 games.

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.

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.*

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.

REFERENCES

Apor P (1988). Successful formulae for fitness training. In T Reily, A Lees, K Davids, WJ Murphy (Eds). *Science and Football*. London: E and FN Spon. Pp. 95-107

Bangsbo J (1994). Energy demands in competitive soccer. *Journal of Sports Sciences*, 12, S5-S12.

Borms J (1986). The child and exercise: an overview. *Journal of Sports Sciences*, 4, 3-20.

Drust B, Reilly T (1997). Heart rate responses of children during soccer play. In T Reilly, J Bangsbo, M Hughes (Eds). *Science and Football III*. London: E and FN Spon. Pp. 196-200.

Drust B, Reilly T, Cable NT (2000). Physiological responses to laboratory-based soccer-specific intermittent and continuous exercise. *Journal of Sports Sciences*, 18, 885-892.

Ekstrand J (1982). Soccer injuries and their prevention. *Thesis, Linköping University, Medical Dissertation* 130.

Klimt F, Betz M, Seitz U (1992). Metabolism and circulation system of children playing soccer. In J Coudert, E Van Praagh (Eds). *Children and Exercise XVI: Paediatric Work Physiology*. Paris: Maason. Pp. 127-129.

Kohnon T, O'Hata N, Ohara M, Shirahata T, Endo Y, Satoh M, Kimura Y, Nakajima Y (1997). Sports injuries and physical fitness in adolescent soccer players. In T Reilly, J Bangsbo, M Hughes (Eds). *Science and Football III*. London: E and FN Spon. Pp. 185-189

Lindquist F, Bangsbo J (1993). Do young soccer players need specific physical training? In T Reilly, J Clarys, A Stibbe (Eds). *Science and Football II*. London: E and FN Spon. Pp 275-280.

Platt D, Maxwell A, Horn R, Williams M, Reilly T (2001). Physiological and technical analysis of 3 v 3 and 5 v 5 youth football matches. Insight: *The F. A. Coaches Association Journal*, 4 (4), 23-24.

Reilly T (1997). Energetics of high intensity exercise (soccer) with particular reference to fatigue. *Journal of Sports Sciences*, 15, 257-263.

Reilly T, Ball D (1984). The net physiological cost of dribbling a soccer ball. *Research Quarterly for Exercise and Sport*, 55, 267-271.

Reilly T, Stratton G (1995). Children and adolescents in sport: physiological considerations. *Sports Exercise and Injury*. 1, 207-213.

Reilly T, Thomas V (1979). Estimated daily energy expenditures of professional association footballers. *Ergonomics*, 22, 541-548.

Reilly T, Bangsbo J, Franks A (2000). Anthropometric and physiological predispositions for elite soccer. *Journal of Sports Sciences*, 18, 669-683.

Reilly T, Williams AM, Nevill A, Franks A (2000). A multidisciplinary approach to talent identification in soccer. *Journal of Sports Sciences*, 18, 695-702.

Segers V, De Clercq D, Philippaerts R, Jonssens M (2002). Running economy in early and late mature youth soccer players. In P Aerts, K D'Aout, A Herrel, R Van Damme (Eds). *Topics in Functional and Ecological Vertebrate Morphology*. Maastricht: Shaker Publishing. Pp. 125-138.

Strudwick A, Reilly T, Doran D (2002). Anthropometric and fitness profiles of elite players in two football codes. *Journal of Sports Medicine and Physical Fitness*, 42, 239-242.

Wagenmakers AJ, Brooks JH, Coakley JH, Reilly T, Edwards RHT (1989). Exercise-induced activation of the branched chain 2-oxo acid dehydrogenase in human muscle. *European Journal of Applied Physiology*, 59, 159-167.

Wisloff U, Helgerud J, Hoff J (1998). Strength and endurance of elite soccer players. *Medicine and Science in Sports and Exercise*, 30, 462-467.

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CHAPTER 12: WORKLOAD AND PERCEPTION OF EFFORT IN SWIM TRAINING

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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 et al 1985; Borg, 2000). The signs, perceptions and experiences are integrated into a global configuration labelled the perception of effort. These scales have been used to evaluate the fatigue or physiological stress in isolated tasks (Maglischo, 1993; Wilmore and Costill, 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).

a) 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 can be defined trough 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 (Borg, 2000). Therefore, it is necessary to quantify the perception of effort, which is not a measure by itself.

b) Scales of perception of effort

The capacity to evaluate level of effort is highly developed in humans (Noble and Robertson, 1996; Borg, 2000; Dekerle et al, 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 Robertson, 1996; ACSM, 2000; Dekerle et al, 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.

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
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	
9	Very difficult	Improves anaerobic capacity anaerobic and VO_2 max; intensity is above the present anaerobic threshold	Lactate tolerance End-3
10	Extremely difficult	Improves anaerobic metabolism	Lactate tolerance

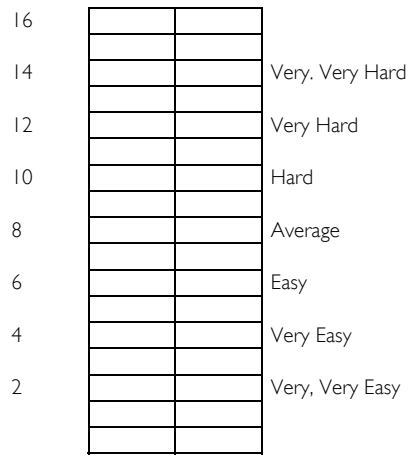

Figure 2 Rating of weekly training load (*RTL) scale* (adapted from Berglund and Säfstrom,1994)

Maglischo (1993) related the 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). In a study of 14 elite canoeists, 9 men

and 5 women, a strait relationship was found 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).

c) 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 (Hamilton et al 1996). 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 (Noble and Robertson, 1996).

METHODS

The sample included 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

	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
Armspan, (cm)	165.4 ± 6.6	176.1 ± 4.9	159.8 ± 7.3	179.7 ± 8.1

All of the participants registered their level of perception of effort in a log-book recording using the two scales mentioned 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.

Athletes 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. The use of the total distance swam does not clearly reflect the physiological stress produced at different levels of intensity. 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 (Maglischo, 1988; Mujika *et al*.,1995; Vadivieso, 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.

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 training session.

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

RESULTS

a) 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. During the study period, the national level group 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: 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	27,742 ± 4,270	2.50	$\leq$0.05
	Regional	24,170 ± 5,357		
Total Volume, (m)	National	728,470 ± 132,722	2.39	$\leq$0.05
	Regional	626,053 ± 157,124		
Mean week Intensity, (AUL)	National	14.3 ± 4.3	1.94	n.s.
	Regional	12.5 ± 3.9		
$\sum$ of (AUL)	National	377.3 ± 122.9	1.53	n.s.
	Regional	324.8 ± 109.8		

The volumes of national level swimmers are significantly ($p \leq 0.05$) 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 ($p \leq 0.05$) 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	32,519 ± 7,821	2.609	≤0.05
	Regional	26,605 ± 7,550		
VOL11	National	21,547 ± 5,009	2.298	≤0.05
	Regional	18,025 ± 5,380		
VOL15	National	36,730 ± 9,030	3.495	≤0.01
	Regional	26,252 ± 10,838		
VOL16	National	29,105 ± 9,808	2.403	≤0.05
	Regional	22,053 ± 8,424		
VOL18	National	34,359 ± 6,227	3.405	≤0.01
	Regional	26,388 ± 9,138		
VOL21	National	31,704 ± 8,529	2.743	≤0.01
	Regional	23,917 ± 10,611		
VOL24	National	29,404 ± 6,116	2.375	≤0.05
	Regional	25,309 ± 5,567		

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	17.3 ± 4.6	2.16	≤0.05
	Regional	14.2 ± 5.1		
INT11	National	12.9 ± 4.6	2.29	≤0.05
	Regional	10.0 ± 3.7		
INT13	National	14.9 ± 5.2	2.19	≤0.05
	Regional	11.4 ± 5.7		
INT15	National	17.6 ± 5.6	2.86	≤0.01
	Regional	12.7 ± 5.6		
INT16	National	14.7 ± 7.2	2.16	≤0.05
	Regional	10.4 ± 4.9		
INT18	National	18.2 ± 5.5	2.01	≤0.05
	Regional	14.8 ± 5.9		
INT19	National	15.1 ± 5.8	2.38	≤0.05
	Regional	11.2 ± 5.4		
INT21	National	14.2 ± 5.3	2.02	≤0.05
	Regional	10.9 ± 5.8		

b) Perception of effort

There were no significant differences in perceived effort between male and female swimmers. Hence, the data are reported for the sexes combined.

b.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 used low training load. 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	≤0.05
	Regional	8.68 + 1.46		
RTL14	National	9.45 + 1.87	2.29	≤0.05
	Regional	8.05 + 2.19		
RTL22	National	10.05 + 1.80	3.65	≤0.01
	Regional	8.00 + 1.88		
RTL23	National	10.23 + 1.77	2.99	≤0.01
	Regional	8.22 + 2.63		
RTL24	National	11.14 + 3.21	2.75	≤0.01
	Regional	8.65 + 2.84		
RTL25	National	10.30 + 2.30	4.27	≤0.01
	Regional	7.83 + 1.56		
RTL26	National	9.30 + 2.42	3.03	≤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 of 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 and by mechanisms of accumulated fatigue in these swimmers.

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. However, when analysing the temporal coincidence of training load and perception of effort, only at weeks 22 and 25 the differences in perception of effort were coincident with differences in volume swam by the two groups. For intensity, this occurred 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 duties, 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	4.30 ± 1.83	2.425	≤0.01
	Regional	3.71 ± 1.35		
Cr10 17	National	5.13 ± 2.24	2.076	≤0.05
	Regional	4.03 ± 1.38		
Cr10 23	National	5.64 ± 1.68	4.403	≤0.01
	Regional	3.59 ± 1.65		
Cr10 24	National	6.27 ± 2.69	4.075	≤0.01
	Regional	4.09 ± 2.15		
Cr10 25	National	5.04 ± 2.18	3.015	≤0.01
	Regional	3.52 ± 1.12		
Cr10 26	National	4.72 ± 2.20	2.972	≤0.01
	Regional	3.06 ± 1.30		
Cr10 27	National	2.95 ± 1.35	2.366	≤0.05
	Regional	2.07 ± 1.02		

b.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). These results are consistent with those obtained with the RTL scale, since the 7th week show the highest mean volume swam by this group.

b.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	$\leq$0.01
	Regional	23	3.57 ± 0.76		
RTL	National	23	9.09 ± 0.88	3.725	$\leq$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.

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

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.

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			

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

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 follow higher training loads, were observed.

Although the majority of this sample was 16 to 18 years old, 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 final 6 to 7 weeks. It appears that perception of effort is affected by participation in competitions and/or the approach of important competitions.

As a final mark is suggest that the use of perception of effort scales can work as auxiliary instruments to monitor swimming training . The scales showed strong correlation with the volume and intensity of training. Both scales (CR10 and RTL) have similar potential to function as instruments to help monitor and control the training process in swimming.

REFERENCES

American College of Sports Medicine. (2000) Guidelines for Exercise Testing and Prescription. 6ª Ed. Baltimore, Williams & Williams.

Dekerle J, Baron B, Dupont L, Garcin M, Vanvelcenaher J, & Pelayo, P. (2003). Effect of incremental and submaximal constant load tests protocol on perceived exertion (CR10) values. Percept Mot Skills, 96(3): 896-904.

Ben-Sira D (1986). The Perception of effort during physical exercise. In Zaichowsky L. & Fuchs C (Eds) The psychology of motor behaviour**:** development, control, learning and performance (pp 175-191). Ithaca, NY. Movements Publications, Inc.

Berglund B, Safstrom H (1994). Psychological monitoring and modulation of training load of world-class canoeists. *Medicine & Science in Sports & Exercise*, vol. 26 (8): 1036-1040.

Borg G (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise* Vol. 14 (5): 377-381.

Borg G (1985). *An introduction to Borg's RPE scale*. Ithaca, NY. Mouvement Publications.

Borg G, Ljunggren G, Ceci R (1985). The increase of perceived exertion, aches and pain in the legs, heart rate and blood lactate during exercise on a bicycle ergometer. *Eur. J. Applied Physiology*, 54: 343-349.

Borg G (2000). *Escalas de Borg para a Dor e o Esforço Percebido*. São Paulo. Manole.

Chatard, JC, & Mujika, I (1999). *Training Load and Performance in Swimming*. In KL Keskinen & PV Komi & AP Hollander (Eds.), Biomechanics and Medicine in Swimming VIII (pp. 429-434). Jyvaskyla: Gummerus Printing.

Hamilton, AL, Killian, KJ, Summers, E, & Jones, NL (1996). Quantification of intensity of sensations during muscular work by normal subjects. J Appl Physiol, 81(3): 1156-1161.

McNair DM, Lorr M, Droppleman LF (1992). *Profile of Mood States Manual*. Educational and Industrial Testing Service. San Diego

Maglischo EW (1988). Application of energy metabolism to swimming training. In: *Swimming Science V* (pp 209-218)., Champaign, IL. Human Kinetics.

Maglischo EW (1993). *Swimming even faster*. Mayfield Publishing Company

Mihevic PM (1981). Sensory cues for perceived exertion: a review. *Medicine and Science in Sports and Exercise*, vol 13, (3): 150-163.

Mujika I, Chatard JC, Busso T, Geyssant A, Barale F, Lacoste L (1995). Effects of Training on Performance in Competitive Swimming *Can. J. Appl. Physiol.* 20: 395-406.

Noble B & Robertson R (1996). *Perceived Exertion*. USA: Human Kinetics.

Rushall B (1995). Training prescription: the relationships of technique, overload, and specificity. *Carlile Coaches' Forum*. Vol 2 (4). San Diego State University.

Valdeviesso F, Navarro Feal AR (2001). *Planificación y Control del Entrenamiento en Natación*. Madrid. Editorial Gymnos.

Weltman A (1995). *The Blood Lactate response to exercise*. Champaign. IL: Human Kinetics

Wilmore J, Costill D, (1994). *Physiology of Sport and Exercise*. Champaign, IL. Human Kinetics.

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CHAPTER 13: INJURY IN YOUTH SPORTS – surveillance, risk and rates

Robert M Malina

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. The following statement would seem to suggest that injury in youth sport is reaching epidemic proportions:

> "Around the country, doctors say it is as if they have happened upon a new childhood disease, and the cause is the *overaggressive culture of organized youth sports*. … *They are overuse injuries pure and simple*. … You get a kid on the operating table and you say to yourself, 'It's impossible for a 13-year-old to have this kind of wear and tear.' *We've got an epidemic going on*" (Pennington, 2005, italics mine).

The purpose of this chapter is to review issues related to injury surveillance, risk factors for injury and rates of injury among participants in youth sports.

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.

a) 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.

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.

a) 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*., 2004), 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?

b) 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.

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.

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.

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.

a) 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.

b) 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.

c) Surveys of Specific Sports - European Football (Soccer)

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. 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.

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 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.

A more recent summary of deaths attributed to hypertrophic cardiomyopathy indicates several trends: (1) cases are limited primarily to males, (2) cases do not include prepubertal children, (3) cases include disproportionally more athletes of Black ancestry, and (4) the clinical scenario is not consistent with suddent death associated with exertion in non-athletic situations (Rowland, 2007). The lack of fit between observations on hypertrophic cardiomyopathy in athletes and the general population suggests a potential role for training-induced ventricular hypertrophy. Accordingly, it has been proposed that deaths from hypertrohic cardiomyopathy "…are related to fatal dysrhythmias in the extraordinarily rare young athlete with an exaggerated hypertrophic response to sports training rather than the expression of occult preexisting…" hypertrophic cardiomyopathy (Rowland, 2007, 0379).

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.

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.

REFERENCES

American Academy of Pediatrics (2000) Injuries in youth soccer: A subject review. *Pediatrics* 105: 659-661.

American Red Cross (1997) *Sport Safety Training Handbook*. St. Louis, MO: Mosby Lifeline.

Andreasen I, Fauno P, Lund B, Lemche P, Knudsen H (1992) Soccer injuries among youth. *Scandinavian Journal of Medicine and Science in Sports* 3:62-66.

Backhous DD, Friedl KE, Smith NJ, Parr TJ, Carpine WD (1988) Soccer injuries and their relation to physical maturity. *American Journal of Diseases of Children* 142: 839-842.

Baxter-Jones A, Maffulli N, Helms P (1993) Low injury rates in elite athletes. *Archives of Disease in Childhood* 68: 130-132.

Behrman RE (ed) (2000) Unintentional injuries in childhood. *The Future of Children* 10, no 1 (Spring/Summer).

Bijur PE, Trumble A, Harel Y, Overpeck MD, Jones D, Scheidt PC (1995) Sports and recreation injuries in US children and adolescents. *Archives of Pediatric and Adolescent Medicine* 149: 1009-1016.

Blyth CS, Mueller FO (1974) Football Injury Survey, Part 3: Injury rates vary with coaching. *The Physician and Sportsmedicine* 2: 45-50 (Nov).

Caine DJ, Lindner K (1990) Preventing injury to young athletes. Part 1: Predisposing factors. *Canadian Association for Health, Physical Education and Recreation Journal* 56: 30-35 (Mar/Apr).

Dameron TB, Reibel DB (1969) Fractures involving the proximal humeral epiphyseal plate. *Journal of Bone and Joint Surgery* 51A: 289-297.

DeLee JC, Farney WC (1992) Incidence of injury in Texas high school football. *American Journal of Sports Medicine* 20: 575-580.

Ellison LF, Mackenzie SG (1993) Sports injuries in the database of the Canadian Hospitals Injury Reporting and Prevention Program - an overview. *Chronic Disease Canada* 14: 96-104.

Hergenroeder AC (1998) Prevention of sports injuries. *Pediatrics* 101: 1057-1063.

Inklaar H, Bol E, Schmikli SL, Mosterd WL (1996) Injuries in male soccer players: Team risk analysis. *International Journal of Sports Medicine* 17: 229-234.

Iuliano-Burns S, Mirwald RL, Bailey DA (2001) The timing and magnitude of peak height velocity and peak tissue velocities for early, average and late maturing boys and girls. *American Journal of Human Biology* 13: 1-8.

Kibler WB, Chandler TJ (1993) Musculoskeletal adaptatioins and injuries associated with intense participation in youth sports. In BR Cahill, AJ Pearl (Eds): *Intensive Participation in Children's Sports*. Champaign, IL: Human Kinetics, pp 203-216.

Kohl HW, Malina RM, Campaigne BN, Dick RW, Duda JL, Harris SS, Hergenroeder AC, Jones BA, Murray DG, Seefeldt V (1996) *Youth sports injury: Risks, causes and consequences*. Indianapolis: American College of Sports Medicine Roundtable.

Kujala UM, Taimela S, Antti-Poika I, Orava S, Tuominen R, Myllynen P (1995) Acute injuries in soccer, ice hockey, volleyball, basketball, judo, and karate: Analysis of national registry data. *British Medical Journal* 311: 1465-1468.

Maffulli N, Chan KM, Macdonald R, Malina RM, Parker AW (2001) *Sports Medicine for Specific Ages and Abilities*. London: Churchill Livingstone.

Malina RM, Bouchard C, Bar-Or O (2004) *Growth, Maturation, and Physical Activity*, 2nd edition. Champaign, IL: Human Kinetics.

Maron BJ, Poliac LC, Kaplan JA, Mueller FO (1995) Blunt impact to the chest leading to sudden death from cardiac arrest during sports activities. *New England Journal of Medicine* 333: 337-342.

Maron BJ, Shirani J, Poliac LC, Mathenge R, Roberts WC, Mueller FO (1996) Sudden death in young competitive athletes: Clinical, demographic, and pathological profiles. *Journal of the American Medical Association* 276: 199-204.

Micheli LJ (1985) Preventing youth sports injuries. *Journal of Physical Education, Recreation and Dance* 56: 52-54 (Aug).

Mueller F, Blyth C (1982) Epidemiology of sports injuries in children. *Clinics in Sports Medicine* 1: 343-352.

Nilsson S, Roaas A (1978) Soccer injuries in adolescents. *American Journal of Sports Medicine* 6: 358-361.

Pennington B (2005) Doctors see a big rise in injuries for young athletes. New York Times 22 February (www.nytimes.com accessed 22 February 2005).

Powell JW, Barber-Foss KD (1999) Injury patterns in selected high school sports: A review of the 1995-1997 seasons. *Journal of Athletic Training* 34: 277-284.

Powell JW, Barber-Foss KD (2000) Sex-related injury patterns among selected high school sports. *American Journal of Sports Medicine* 28: 385-391.

Roberts WO, Brust JD, Leonard B (1999) Youth ice hockey tournament injuries: Rates and patterns compared to season play. *Medicine and Science in Sports and Exercise* 31: 46-51.

Rowland T (2007) Sudden cardiac death in athletes: Rethinking "hypertrophic cardiomyopathy." *Pediatric Exercise Science* 19:373-383.

Sports Council (1992) *TOYA and Sports Injuries*. London: The Sports Council.

Van Camp SP, Bloor CM, Mueller FO, Cantu RC, Olson HG (1995) Nontraumatic sports deaths in high school and college athletes. *Medicine and Science in Sports and Exercise* 27: 641-647.

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CHAPTER 14: RISK OF INJURY IN YOUTH SPORTS - role of psychological factors

Anthony P Kontos

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?

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.

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.

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.

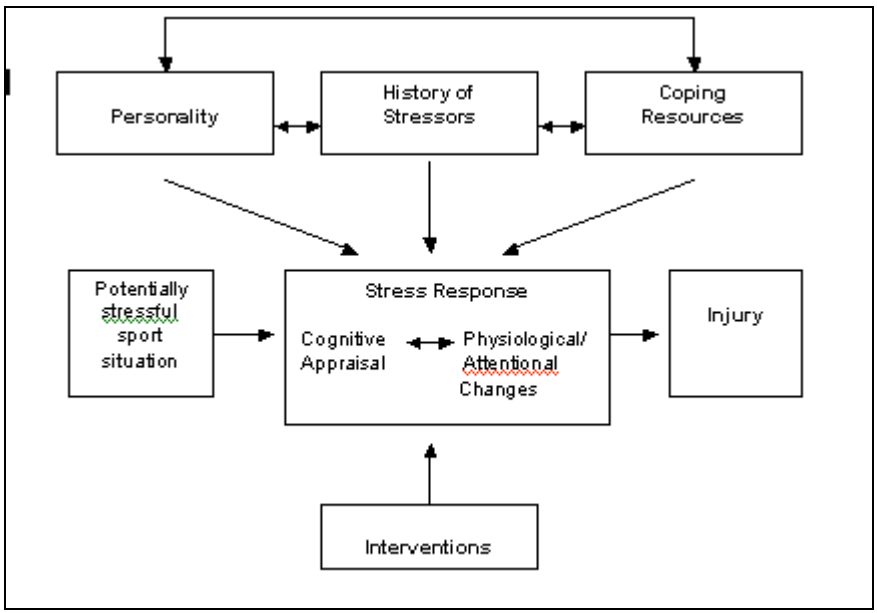

Figure 1. The stress model of injury in youth sport

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

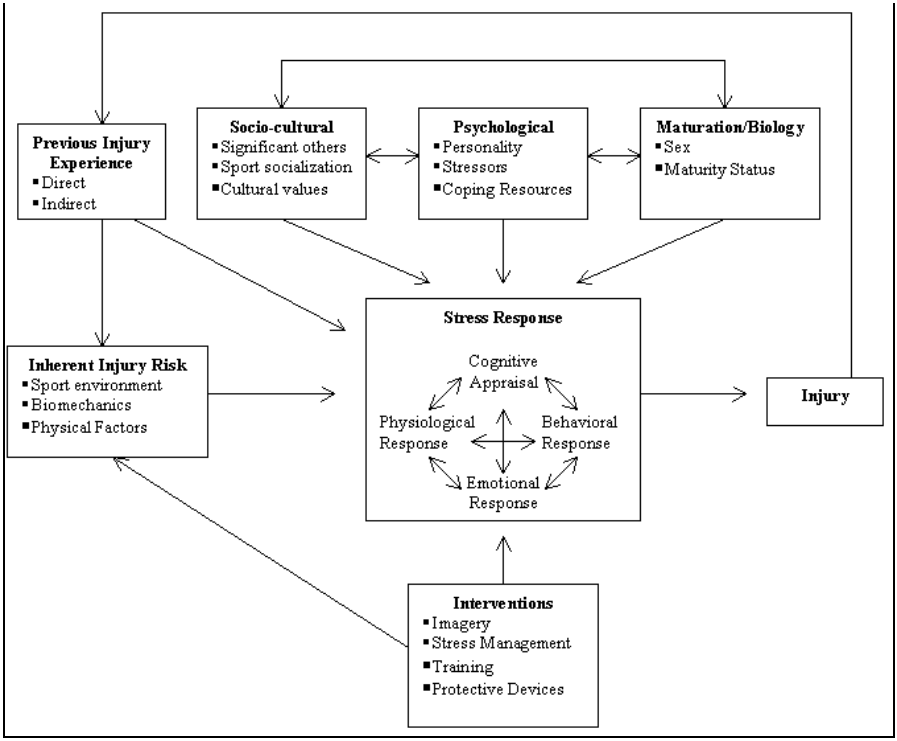

Figure 2. A multidisciplinary revision of the stress model of injury in youth sport.

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.

REFERENCES

Andersen MB, Williams JM (1997). *Athletic injury, psychosocial factors, and perceptual changes during stress*. Unpublished manuscript.

Andersen MB, Williams JM (1988). A model of stress and athletic injury: Prediction and prevention. *Journal of Sport and Exercise Psychology.* 10: 294-306.

Backx FJ, Beijer HJ, Bol E, Erich WB (1991). Injuries in high-risk persons and high-risk sports. *The American Journal of Sports Medicine.* 19: 124-130.

Bandura A (1997). *Self-efficacy: The exercise of control*. New York: Freeman and Co.

Bijur PE, Trumble A, Harel Y, Overpeck MD, Jones D, Scheidt PC (1995). Sports and recreation injuries in US children and adolescents. *Archives of Pediatric and Adolescent Medicine.* 149: 1009-1016.

Blackwell McCullagh (1990). The relationship of athletic injury to life-stress, competitive anxiety, and coping resources. *Athletic Training.* 25 (1): 23-27.

Bonci CM (1999). Assessment and evaluation of predisposing factors to anterior cruciate ligament injury. *Journal of Athletic Training.* 34: 155-164.

Bramwell ST, Matsuda M, Wagner NH, Holmes TH (1975). Psychological factors in athletic injuries: Development and application of the Social and Athletic Readjustment Rating Scale (SARRS). *Journal of Human Stress.* 6 : 3-5.

Brenner ND, Collins JL (1998). Co-occurrence of health-risk behaviors among adolescent in the United States. *Journal of Adolescent Health.* 22 : 209-213.

Hanson SJ, McCullagh P, Tonymon P (1992). The relationship of personality characteristics, life stress, and coping resources to athletic injury. *Journal of Sport and Exercise Psychology.* 14: 262-272.

Ireland ML (1999). Anterior cruciate ligament injury in female athletes: Epidemiology. *Journal of Athletic Training.* 34: 150-154.

Jackson DW, Jarrett H, Bailey D, Kausek J, Swanson J, Powell JW (1978). Injury prediction in the young athlete: A preliminary report. *American Journal of Sports Medicine.* 6: 6-14.

Junge A (2000). The influence of psychological factors on sports injuries: Review of the literature. *American Journal of Sports Medicine.* 28: S10-S15.

Kleinert J (2002). An approach to sport injury trait anxiety: Scale construction and structure analysis. *European Journal of Sport Science.* 2: 1-12.

Kontos AP (2000). The effects of perceived risk. risk taking behaviors. and body size on injury in youth sport. *Unpublished doctoral dissertation*. Michigan State University. East Lansing. MI.

Kontos AP (1995). Perceptions of coaching behaviors and selected variables on injury occurrence in female youth soccer players. *Unpublished master's thesis*. Michigan State University. East Lansing. MI.

Kontos AP (2002). Psychosocial antecedents of heading exposure, concussion and neurocognitive symptoms among adolescent soccer players. Paper presented at the *New Developments in Sports Concussion Conference*. Pittsburgh. PA.

Kontos AP, Foret KL (2001). A meta-analytic review of the life stress and injury relationship in sport. Paper presented at the *Association for the Advancement of Applied Sport Psychology Conference*. Orlando. FL.

Kontos AP, Malina RM, Feltz DL (1999). The development and validation of the Perception of Risk of Injury in Sports Scale (PRISSc). Presentation at the *Youth Sport in the 21st Century Conference*. Michigan State University. East Lansing. MI.

Lysens RJ, Ostyn MS, Vanden Auweele Y, Lefevre J, Vuylsteke M, Renson L (1989). The accident-prone and overuse-prone profiles of the young athlete. *American Journal of Sports Medicine.* 17: 612-619.

Matser JT, Kessels AGH, Jordan BD, Lezak MD, Troost J (1999). Chronic traumatic brain injury in professional soccer players. *Neurology.* 51: 791-796.

Mugno DA, Feltz DL (1985). The social learning of aggression in youth football in the United States. *Canadian Journal of Applied Sport Sciences.* 10: 26-35.

Nicholl JP, Coleman P, Williams BT (1995). The epidemiology of sports and exercise related injury in the United Kingdom. *British Journal of Sports Medicine.* 29: 232-238.

Passer MW, Seese MD (1983). Life-stress and athletic injury: Examination of positive versus negative events and three moderator variables. *Journal of Human Stress.* 9: 11-16.

Petitpas A, Danish S (1995). Caring for injured athletes. In S Murphy (Ed.). *Sport psychology interventions* (pp. 255-281). Champaign. IL: Human Kinetics.

Petrie TA (1993). The moderating effects of social support and playing status on the life stress-injury relationship. *Journal of Applied Sport Psychology.* 5: 1-16.

Petrie TA (1992). Psychosocial antecedents of athletic injury: The effects of life stress and social support on female collegiate gymnasts. *Behavioral Medicine.* 18: 127-138.

Powell JW, Barber-Foss KD (2000). Sex-related injury patterns among selected high school sports. *American Journal of Sports Medicine.* 28: 385-398.

Powell JW, Barber-Foss KD (1999). Injury patterns in selected high school sports: A review of the 1995-1997 seasons. *Journal of Athletic Training.* 34: 277-284.

Potts R, Martinez IG, Dedmon A (1995). Childhood risk taking and injury: Self-report and informant measures. *Journal of Pediatric Psychology.* 20 (1): 5-12.

Scanlan TK (1986). Competitive stress in children. In MR Weiss, D Gould (Eds.). *Sport for children and youths*. Champaign. IL: Human Kinetics. Pp: 113-118

Shields DL, Bredemeier BJ (1995). *Character development and physical activity.* Champaign. IL: Human Kinetics.

Shields DL, Bredemeier BJ, Gardner DE, Bostrom A (1995). Leadership. cohesion. and team norms regarding cheating and aggression. *Sociology of Sport Journal.* 12: 324-336.

Short S, Muir V, Eickhoff D, Kontos AP, Short M (2001) Relationships among perceptions of risk of injury, fear of injury, and confidence in avoiding injury in collision/contact sports. Paper presented at the *North American Society for the Psychology of Sport and Physical Activity Conference*. St. Louis. MO.

Smith RE, Ptacek JT, Smoll FL (1992). Sensation seeking, stress, and adolescent injuries: A test of stress-buffering, risk-taking, and coping skills hypotheses. *Journal of Personality and Social Psychology.* 62: 1016-1024.

Smith RE, Ptacek JT, Smoll FL (1990). Conjunctive moderator variables in vulnerability and resiliency research: Life stress, social support and coping skills, and adolescent sport injuries. *Journal of Personality and Social Psychology.* 58: 360-369.

Smoll FL, Smith RE (1990). Psychology of the young athlete: Stress-related maladies and remedial approaches. *Pediatric Clinics of North America.* 3: 1021-1046.

Straub WF (1982). Sensation seeking among high and low risk male athletes. *Journal of Sport Psychology.* 4: 246-253.

Stuart ME, Ebbeck V (1995). The influence of perceived social approval on moral development in youth sport. *Pediatric Exercise Science.* 7: 270-280.
Taerk G (1977). The injury prone athlete: A psychosocial approach. *Journal of Sports Medicine and Physical Fitness.* 17: 187-194.
Taimela S, Osterman L, Kujala U, Lehto M, Korhonen T, Alaranta H (1990). Motor ability and personality with reference to soccer injuries. *Journal of Sports Medicine and Physical Fitness.* 30: 194-201.
Whieldon TJ, Cerny FJ (1990). Incidence and severity of high school athletic injuries. *Athletic Training.* 25: 344-349.
Williams J, Andersen M (1998). Psychosocial antecedents of sport injury: Review and critique of the stress and injury model. *Journal of Applied Sport Psychology.* 10: 5-25.
Williams J, Roepke N (1993). Psychology of injury and injury rehabilitation. In RN Singer, LK Tennant, M Murphey (Eds.). *Handbook of research on sport psychology* (pp. 815-839). New York: McMillan.
Williams JM, Tonymon P, Wadsworth WA (1986). Relationship of stress to injury in intercollegiate volleyball. *Journal of Human Stress.* 12: 38-43.
Wittig AF, Schurr KT (1994). Psychological characteristics of women volleyball players: Relationships with injuries, rehabilitation, and team success. *Personality and Social Psychology Bulletin.* 20: 322-330.

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