Children and Youth in Organized Sports
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(Editors)

CHILDREN AND YOUTH IN ORGANIZED SPORTS

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PREFACE

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

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

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

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

Manuel Coelho e Silva
Robert M. Malina
Editors
FOREWORD

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

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

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

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

**ACHIEVEMENT GOAL ORIENTATION THEORY**

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

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

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

ATTRIBUTION THEORY

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

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

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

**EXPECTANCY-VALUE THEORY**

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

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

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

SUMMARY OF THEORIES OF PARENTAL INFLUENCE

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

3. THE NATURE AND IMPACT OF PARENTAL INFLUENCE

Considerable research has been conducted to examine the links between parents' beliefs and behaviors and children's psychosocial development in sport. The specific types of influence that parents have on their children in sport are numerous and diverse. Theoretically grounded and empirically based studies have identified particular parental beliefs and behaviors that are relevant to participation patterns, emotional responses, self-perceptions, and motivation of young athletes. Table I 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 I. Types of Parental Influence Studied in Youth Sport

<table>
<thead>
<tr>
<th>CONSTRUCT</th>
<th>REFERENCES</th>
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<tr>
<td><strong>I. Parental Exertion</strong></td>
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<td><strong>II. Parental Beliefs</strong></td>
<td></td>
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<tr>
<td>About Competence</td>
<td>Babkes and Weiss (1999), Felson and Reed (1986), McCullagh et al. (1993)</td>
</tr>
<tr>
<td>About value of competence</td>
<td>Eccles and Harold (1991)</td>
</tr>
<tr>
<td>About appropriateness of sport participation</td>
<td>Brown et al. (1989)</td>
</tr>
<tr>
<td><strong>III. Parental Responses to Performance</strong></td>
<td>Scanlan and Lewthwaite (1986)</td>
</tr>
<tr>
<td>Negative Evaluation</td>
<td>Babkes and Weiss (1999), Hellstedt (1990), Scanlan and Lewthwaite (1986)</td>
</tr>
<tr>
<td>Performance Reactions</td>
<td>Babkes and Weiss (1999), Hellstedt (1990), Scanlan and Lewthwaite (1986)</td>
</tr>
<tr>
<td><strong>IV. Parental Behaviors</strong></td>
<td></td>
</tr>
<tr>
<td>Interactions</td>
<td>Scanlan and Lewthwaite (1986), Scanlan et al. (1989)</td>
</tr>
<tr>
<td>Encouragement</td>
<td>Brown et al. (1989), Green and Chalip (1997)</td>
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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 antecedent 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
contrast to that of a maturing adolescent or young adult (Claessens, 1999). These observations can be in large part be attributed to 'selection' based on the direct biomechanical advantages of a prepubertal physique that include increased strength/weight ratio, greater stability, and decreased moments of inertia. Also, in sports in which performance is subjectively scored, as in gymnastics, physical characteristics in addition to skill, may have added significantly for success (Claessens, 1999; Ryan, 1995).

Not surprisingly, whereas the average age and size of competitive gymnasts have decreased, the difficulty of manoeuvres practiced and performed has increased. Frequency, duration, and intensity of training also have increased. Elite-level gymnasts, for example, are reported to train around 40 h/week, 5-6 days/week, the whole year around. On average, these gymnasts may exercise 700 to 1300 elements per day, which correspond to 220 000 to 400 000 elements per year (Caine et al., 1997). These extremely high training demands and changes in expectations of the sport at elite levels (Normile, 1996) has resulted in both public and medical concerns, especially from an auxological point of view (Claessens, 1999; Malina, 2001). It may be postulated that these very young and immature growing athletes are repeatedly subject to numerous microtrauma in general, and more specifically, to chronic, long-term accumulative 'overuse' injuries, caused by strenuous, repetitive loads. Epidemiologic research of injury patterns in male and female gymnasts has been studied extensively by several authors, and reviewed by Caine and co-workers (1996).

Unlike most other sports, gymnastics requires use of the upper extremities as weight-bearing limbs, causing high-impact loads to be distributed through the elbows and wrists (Koh et al., 1992; Markolf et al., 1990). It is not unexpected that injury occurs in these regions (Caine et al., 1996). Among others, wrist pain is often viewed in gymnasts as a result of epiphysial trauma and related changes caused by repetitive gymnastic loading mainly of the distal end of the radius as its interface with the carpals, as claimed by some authors (reviewed by Caine et al., 1997). Further on, some authors claim that repetitive injury to the radial epiphysis may inhibit normal growth of the radius resulting in a 'positive ulnar variance' (Caine et al., 1996, 1997).

The aim of this study is to review the available research concerning the ulnar variance phenomenon as it is connected to the female gymnast.

2. ULNAR-VARIANCE

Ulnar variance refers to the relative positioning of the distal end of the ulna relative to the distal end of the radius. If the distal end of the ulna is more distally located as compared to the distal end of the radius, then the term positive ulnar variance (or ulnar overgrowth) is used. When the opposite is
seen, i.e. the distal end of the ulna is more proximal located as compared to the distal end of the radius, the phenomenon is called negative ulnar variance (Hafner et al., 1989). Ulnar variance is mostly determined on postero-anterior radiographs of the hand and wrist, whereby several measuring methods are at hand. Different techniques has to be used for mature and immature wrists (Hafner et al., 1989; Kristensen et al., 1986; Palmer et al., 1982; Steyers and Blair, 1989).

3. FINDINGS FROM CASE REPORTS AND CROSS-SECTIONAL STUDIES

In general, it has been proposed by several authors that the repetitive stress experienced by the skeletally immature wrist during gymnastics training (especially in the young female elite gymnast) may lead to the development of wrist pain, partial arrest of the distal radial growth plate, and the subsequent development of positive ulnar variance. This proposal suggests thus a dose-response relationship, i.e. the closure of the radial growth plate, caused by the gymnastic training load, results in a positive ulnar variance. This line of reasoning is largely based on 'patients' or 'case'-reports, i.e. those individuals who present themselves to a clinic with wrist pain, and on cross-sectional studies in which a relatively small number of both non-elite and elite gymnasts were studied (Albanese et al., 1989; Aldridge, 1987; Carter and Aldridge, 1988; Chang et al., 1995; DiFiori et al., 1997; Mandelbaum et al., 1989). Although, on average, a positive ulnar variance in most studies could be observed, results were contradictory and controversial conclusions were made. Also, because of the small sample sizes and the selective recruitment, the subjects under study were not necessary representative of the elite gymnastic population. To our knowledge, up till now, only one study is carried out in which a representative sample of outstanding female gymnasts was undertaken (Claessens et al., 1996; De Smet et al., 1994). Ulnar variance was obtained in 201 female gymnasts, all participants at the 24th World Championships Artistic Gymnastics, held at Rotterdam, The Netherlands, October 1987 (Claessens et al., 1991). The gymnasts under study came from 27 (from in total 31) countries. Based on the final results for total team scores, the four teams that declined ranked 2nd, 13th, 15th, and 19th. It can thus be said that the gymnasts under study were a representative sample of the elite female gymnastic population as demonstrated by the number of subjects studied (n=201), high level of training (on average 27 hours per week, varying from 13 to 48 hours per week), competition level (world championships), and representativeness of nationalities. A negative mean value for ulnar variance (Mean= -1.4±2.6 mm) was obtained, demonstrating thus a negative ulnar variance in this high elite female gymnasts. Further on, it was demonstrated that no relationship between ulnar variance on the one hand, and training and competition level on the other hand could be observed. Based on these...
results, authors could not support the dose-response relationship. These results were in accordance with the data of DiFiori et al. (1997) in non elite female gymnasts.

4. RESULTS FROM LONGITUDINAL STUDIES

It is demonstrated that results from different studies give controversial conclusions. This is not directly surprising, because the design of these investigations, i.e. cross-sectionnally, does not allow to draw a real cause and effect relationship. Thus, well-controlled longitudinal studies, in which elite gymnasts were followed for several years, were needed, in which the dose-response relationship between gymnastic training and the ulnar variance phenomenon can be studied in a more effective way.

In a longitudinal study, 36 female gymnasts were annually followed for four or five occasions, with a total of 158 observations (Claessens et al., 1997). At the first observation, the age of the girls varied between 6 and 14 year. According to their training level (based on the total hours of gymnastic training per week) the total group could be divided in three subgroups: (1) a 'top-level' group (n=13, with 15 hours training / week); (2) a 'subtop' group (n=13, with about 5 to 7 hours training / week), and (3) a 'recreational' group (n=10, with about 1 to 2 hours training / week). Besides stature and weight, ulnar variance was determined according to the method of Hafner et al. (1989) for immature wrists. Results for ulnar variance demonstrated that for all age categories a negative value was observed, which means that the distal end of the radius exceeds the distal end of the ulna. With increasing age, this negative ulnar variance became more pronounced, the mean varying from –3.4 mm to –6.5 mm. These results were rather uncommon and this from two viewpoints. Firstly, compared to reference girls (Hafner et al., 1989), where a relatively stable negative ulnar variance pattern can be observed throughout the growth period, varying between –2.5 mm at the age of 6 year and –2.8 mm at the age of 15 year; whereas in the gymnasts’ sample, an increase in negative ulnar variance could be obeserved throughout the period studied. Secondly, based on the available literature, a rather ‘positive ulnar variance’ was expected. However, this was not the case in this longitudinal study, indicating that, in the sample studied, gymnastic training seems not to have a negative impact on the ulnar variance phenomenon. This observation was analyzed more in detail in that way, that two extreme groups with different training loads, were also compared. Results from these analyses revealed that no statistical differences in ulnar variance between the ‘top-level’ and the ‘recreational’ groups could be observed. Based on the results and within the limitations of their study, Claessens and co-workers (1997) came to the conclusion that the ulnar variance pattern is not directly caused by the gymnastic training load, and
could not support the dose-response relationship. It is, however, clear that more longitudinal and intervention studies are needed before more exclusive interpretations can be made.

5. FACTORS RELATED TO THE ULNAR VARIANCE PHENOMENON

5.1. Methodological concerns

Different methods are at hand to measure ulnar variance in both mature and immature wrists (Hafner et al., 1989; Kristensen et al., 1986; Palmer et al., 1982). As a result discrepancies between results were obtained using different techniques and data from different studies are not directly comparable (Steyers and Blair, 1989).

In most studies ulnar variance is determined on unilateral radiographs arbitrarily chosen. However, some authors (Claessens et al., 1998; DiFiori et al., 1997; Freedman et al., 1998) have focussed on the problem of right versus left symmetry of ulnar variance. The results of these studies, however, are not unequivocal. DiFiori et al. (1997) and Freedman et al. (1998) have demonstrated that an individual's ulnar variance is not uniformly symmetrical with the consequence that results who were obtained from different wrists are not directly comparable. In contrast, in a study on 8 – 14 year old female gymnasts, Claessens et al. (1998) did not find a significant difference between ulnar variance taken from right and left radiographs. Also, differences in ulnar variance could not be observed between the dominant and non-dominant wrists, as determined by the rotational direction a wheel is turned.

5.2. Wrist pain and ulnar variance

Several authors claim that wrist pain in gymnasts is associated with a positive ulnar variance (Caine et al., 1996). However, based on data gathered on 27 girls and 17 boys, who could be classified as non-elite gymnasts, training on average 11.9 hours per week, DiFiori et al. (1997) did not find a significant association between ulnar variance and wrist pain. There was also no significant association between positive radiographic findings and ulnar variance.

5.3. Maturity status and ulnar variance

It is often argued that the less mature the gymnast, the more negative the impact of gymnastic training on the radial growth plate, and as a consequence, a more positive ulnar variance is observed. However, based on data gathered on 156 world-top immature female gymnasts, no significant relationship was found between skeletal age and ulnar variance, \( r=+0.16 \) (Claessens et al., 1996). When the data were analysed more in detail, it was clearly demonstrated that ulnar overgrowth was not associated with advanced
maturity status of the radius or earlier epiphysseo-diaphyseal fusion; rather, ulnar overgrowth was apparently associated with more advanced maturity status of the ulna (Beunen et al., 1999).

5.4. Gymnastic training load and ulnar variance

In most studies, especially case-reports, a dose-response relationship between training and ulnar variance is suggested. Thus, the higher the gymnasts’ training and/or competition level, the more pronounced positive ulnar variance. This cause-effect relationship, however, is not equivocal concluded by all authors and need further consideration. In a study on a representative sample of outstanding (participants world championships) female gymnasts, Claessens et al. (1996) did not find any significant correlation between training status and competition scores on the one hand, and ulnar variance on the other hand, correlation values varying from \( r=-0.11 \) (\( r \) between starting age and ulnar variance) and \( r=+0.15 \) (\( r \) between competition score uneven bars and ulnar variance). Also, DiFiori et al. (1997) did not find a significant association between ulnar variance and training history in 44 non-elite male and female gymnasts, aged 5.8 – 15.8 years. Also, based on data gathered on 36 female gymnasts who were followed longitudinally for four years, Claessens et al. (1997) could not demonstrate a significant influence of gymnastics training load and the ulnar variance phenomenon.

5.5. Body build and ulnar variance

It can be hypothesized that an ‘overweight’ or ‘overfat’ body, or a physique not fully suited for gymnastics, will be more at risk for overload or overuse injuries than a physique that is appropriate for the sport. It can thus be argued that the ‘heavier’ the gymnast, the higher the mechanical load on the gymnasts’ wrists, resulting in a more pronounced positive ulnar variance. With the exception of some studies (Claessens et al, 1996; Boogaerts, 2002), most of the available studies of ulnar variance in gymnasts has taken the bodily characteristics of the subjects and/or patients into account. It is, however, clearly demonstrated, that female gymnasts competing at the elite level with a body physique characterized as relatively tall and a high lean body mass, not fat, are at greater risk in developing a positive ulnar variance.

5.6. Basic motor abilities and ulnar variance

To our knowledge, little is known if there is any relationship between the basic motor capacity or physical fitness condition of the gymnast and ulnar variance. However, it can be argued that the relative positioning of the ulna to the radius can be influenced by some motor abilities, in general, or especially at the wrist region (e.g. strength and flexibility characteristics of the wrist, fingers, and so on). Up till now, in none of the published material concerning
ulnar variance this relationship was investigated. Very recently, this relationship was studied in a group (n=16) of 16-year old (SD=2.0) sub-top female gymnasts. (Vandenbussche, 2002) Significant correlations between ulnar variance and some motor capacities were found: with hyper extension of the fingers (r=+ 0.65); and with hyper extension of the elbow (r=+0.52). The results of this preliminary study suggest that more flexible gymnasts are at greater risk in developing a positive ulnar variance.

6. CONCLUSIONS

Based on the available literature of the ulnar variance in female gymnasts it can be concluded that, compared to the reference values, the observed positive ulnar variance in gymnasts is less ‘dramatic’ than originally stated. We support Rowlands’ comment in his ‘Editor’s Notes’ that “The available information is scant, and much more research is needed, but so far most of these seem to be largely false alarms ... The psyche of the highly trained athlete, on the other hand, may be more susceptible to injury than the epiphysis” (Rowland, 1993, p. 300). However, the observed data from the literature poses at least the possibility that growth can be affected and the condition must certainty be taken seriously. More research is needed, especially well designed longitudinal studies taking into account a broad spectrum of factors which are connected to the ulnar variance phenomenon. Finally, the importance of optimal training programs, supervised by well-educated coaches, together with the guidance of the young gymnast by a highly qualified medical team, cannot be stressed enough.

7. REFERENCES


