This is to certify that the

dissertation entitled

THE PSYCHOBIOLOGICAL PROFILE
OF COMPETITIVE FEMALE FIGURE SKATERS

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Kinesiology

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Date 12/10/99

THE PSYCHOBIOLOGICAL PROFILE

OF COMPETITIVE FEMALE FIGURE SKATERS

By

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A Dissertation

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the Degree of

DOCTOR OF PHILOSOPHY

Department of Kinesiology

1999.

ABSTRACT

THE PSYCHOBIOLOGICAL PORFILE OF

COMPETITIVE FEMALE FIGURE SKATERS

By

Eva A. Vadocz

The purpose of this interdisciplinary study was to assess the physical and psychological characteristics of competitive female figure skaters across chronological age groups, level of competency (test, pre-elite and elite), disciplinary involvement (free, dance and pairs), and menarcheal status. The relationships between physical and psychological characteristics, predictors of self-concept, and predictors of eating disorders were also considered. One hundred and sixty-one female figure skaters 11 to 23 years of age underwent a battery of anthropometric dimensions and psychological measurements. The Heath-Carter anthropometric somatotype was derived. The skaters were also asked about their menarcheal status and recalled age at menarche. Parents reported their educational backgrounds, heights and weights; age at menarche of the mothers was also recalled. Overall, figure skaters are shorter, lighter and leaner, and are later maturing compared to reference data. They have, on average, a balanced somatotype. Physical self-perceptions decrease, while social physique anxiety and risk for eating disorders increase with age. The physical self-perceptions of skaters are generally higher than non-athletes, but are similar to the perceptions of other elite athletes. Figure skaters' risk for eating disorders are generally lower than scores for adolescent bulimic anorexics and adolescent norms, but are somewhat higher than adult gymnasts. The social physique anxiety scores of figure skaters are similar to elite athletes and adult norms, but lower than adolescent gymnasts. Elite and specialized skaters are later maturing, shorter, lighter, leaner, less endomorphic, and more mesomorphic than test or free skaters. Elite and specialized skaters also have more favorable self-perceptions than either test or free skaters, but test and elite skaters have higher social physique anxiety than pre-elite skaters. Dancers report lower self-perceptions and are at greater risk for developing eating disorders than free skaters. Endomorphy, chronological age and Self-Esteem correctly classify the majority of skaters by level of competency and/or discipline. Pre-menarcheal skaters, particularly those who are younger, are smaller, more ectomorphic and more mesomorphic than post-menarcheal skaters. They also have more favorable physical self-perceptions, and lower social physique anxiety and eating disorder risk. Among post-menarcheal skaters ≥16 years, later maturing skaters have longer relative leg length, have thinner skinfold thicknesses, and are less endomorphic than average maturers. The correlation for age at menarche for a small sample (n = 28) of skaters and their mothers is significant (0.60), suggesting both familial and environmental influences in menarcheal timing. Correlations between select physical and psychological variables indicate that shorter and leaner skaters have more favorable psychological characteristics. Multivariate-multiple regression analyses indicate that a set of biological and psychological variables, labeled 'bio-perceptual' predict self-concept. Similarly, biological and psychological variables predict several subscales of the Eating Disorder Inventory, accounting for 14% to 65% of the variances.

To my family.

ACKNOWLEDGEMENTS

The completion of this academic milestone would not have been possible without the support of my family, friends and mentors.

Drs. Thomas Hermann, Dan Yarmey and Craig Hall provided me with the initial opportunities of beginning my educational pursuits in the area of sports psychology, an aspiration I have followed since the age of 13. I am grateful to Dr. Lynnette Young Overby who recruited me to MSU and provided countless opportunities of academic and personal growth throughout my doctoral endeavor. Dr. Deborah Feltz has been a consistent mentor, providing financial, writing, and professional support. This dissertation is my contribution back to the skating community, one that would not be possible without the encouragement of Dr. Robert M. Malina, my committee chair. He is also responsible for heightening my awareness of 'biophobia', converting my research interests to include human biology and countless hours of editing. Gratitude is also extended to my program and dissertation committee members Martha Ewing, Lonnie Rosen, John Hobbenstricker, and Susan Frank who shared their knowledge and expertise. The Canadian Figure Skating Association is credited with funding this project.

I am grateful for my family. My parents, Steve and Eva Vadocz promoted independence and discipline while providing countless opportunities to follow my hopes and dreams. I am also thankful for the Kanelos family who adopted me as their own and helped me maintain my perspective. A special thanks is also extended to the Monsma family who fed and encouraged me throughout the last phase of my dissertation.

Several of my friends also provided support and encouragement throughout this long journey. To Shannon Seigel I owe a million centimeters of thanks for sharing her anthropometric expertise and answering countless questions about human biology. I am thankful for friends such as Victoria Orrego who listened and supported unconditionally. Joe Carlson, Karin Allor, Barb Mozen, Andrea Beach, and Sandra Moritz were also there when I needed them. My long time and dear friends Angela McDonald, Laura Stevenson and Alex Stevens remained consistent supporters throughout many years of academic pursuits and transitions. My new friends Susan Schramm, JoAnn Coe, Anita Atwood and Susan Johnson kept me from getting discouraged during the last leg of this process. I am also thankful for the motivation provided by my colleagues at the University of South Carolina.

To Rick Albrecht I cannot express enough gratitude for his unconditional encouragement and understanding throughout my last two academic stepping stones. His wisdom and passion for sport psychology continue to be my most powerful motivating influences.

Last, but by no means least, I would like to thank Chris Monsma, who gave me encouragement, laughter and a peace – may the end of this journey signify the beginning of one that is new.

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GLOSSARY

Artistic Impression - a criterion in figure skating defined by aesthetics, physical and emotional interpretation of music, and movement flow

Dance skaters - competitive female figure skaters participating in the dance discipline with a male partner

Discipline - categories of figure skating distinguished by elements, artistic requirements, music style and length

EDI Subscales

Body Dissatisfaction - dissatisfaction with the shape of body parts such as hips, buttocks, and the belief that these parts are too big or too fat.

Bulimia - tendency to engage in bingeing that may be followed by the impulse to induce vomiting

Drive for Thinness - excessive concern with dieting, preoccupation with weight, and extreme pursuit of thinness

Ineffectiveness - feelings of general inadequacy, insecurity, and worthlessness, and not being in control of one's life

Interpersonal Distrust - sense of alienation and general reluctance to form close relationships

Introceptive Awareness - lack of confidence in recognizing and accurately identifying emotions or visceral sensations of hunger or satiety

Maturity Fears - wish to retreat to the security of pre-adolescence because of being overwhelmed by the demands of adulthood

Perfectionism - excessive personal expectations of superior achievement

Elite - USFSA or CFSA Junior and Senior participants who have competed in at least one prior national qualifying competition.

Free skater - competitive female figure skaters participating in the singles freestyle discipline

Goodness of Fit - matching of individual characteristics with the demands of the social environment.

Novice - USFSA or CFSA novice competitors who have competed in at least one previous national qualifying competition (e.g., sectionals, divisional)

Pair skaters - competitive female skaters participating in the pair discipline with a male partner

Pre-elite - skaters who compete at the pre-novice and novice competitive stream level which lead to national or sub-national qualifying competitions.

PSDQ subscales

Appearance - satisfaction of general appearance (e.g., physique, face, hair)

Body Fat - satisfaction with body fat on various parts of the body

Coordination - perceptions of coordination and agility

Endurance - perceptions of aerobic fitness

Flexibility - perceptions of flexibility of various body parts

Global Physical Self-concept - satisfaction with the overall physical self

Health - perceptions of overall health

Physical Activity - perceptions of involvement in overall physical activity

Self-Esteem - An overall sense of confidence and self-worth

Sport Competence - perceptions of level of proficiency in sport

Strength - self perceptions of muscular strength

Social Physique Anxiety - anxiety that individuals experience in response to others' evaluations of their physique

Test skaters - skaters participating in advanced recreational programs who do not compete at the national or sub-national level

CHAPTER I

Introduction

Sport specialization, especially in subjectively evaluated sports such as gymnastics, diving, and figure skating, begins at relatively young ages. Physical and psychological characteristics related to successful performance are often considered in the process of selective issues related to identifying and selecting potentially talented athletes. However, becoming an elite athlete involves a complex process of selective issues related to self, parents, coaches and sport officials, in addition to exceptional physical and psychological skills. Physical self-perceptions, regardless of physique and body size, is other factors that can affect performance.

For the developing figure skater, critical periods of selection often overlap with adolescence, which is variable in timing and which is associated with a variety of behavioral, physical and physiological changes. Changes in size, proportions, physique and body fat associated with the adolescent growth spurt and sexual maturation occur at important points in the careers of young athletes. They may add to the stresses inherent in figure skating. For example, females increase from an average height of 144 cm and average weight of 37 kg to 158 cm and 48 kg, respectively, from 11 to approximately 16 years (Hamill et al., 1977). In addition to broadening skeletal breadths and increases in muscle mass and limb circumferences, females also progress from an estimated 8% body fat at the beginning of puberty to about 22% at the end of puberty (Killen et al., 1992). These changes reflect modifications in physique and body composition.

For girls, adolescence is often marked by distortions of body image and a desire to be thinner (Attie and Brooks-Gunn, 1989). In addition, changes associated with the adolescent growth spurt and sexual maturation may make it difficult for many skaters to maintain a biomechanically efficient physique necessary to perform technical elements such as jumps, lifts and spins.

In figure skating, as in other subjectively evaluated movement forms such as dance and gymnastics, subjective impressions of body form are often added to the artistic merit of the performance (Ryan, 1995; Ross et al., 1977; Swoap and Murphy, 1995). Propelling the body into the air while exuding artistic expression is a demand common to all competitive skating disciplines, including singles, dance and pairs. Physique is an important feature of a successful figure skater whether for aesthetic purposes or movement efficiency. For example, female pair skaters appear to be generally petite and short compared to female dancers who are taller and more linear. Short stature and a slender physique are important for female pair skaters since many technical maneuvers involve over-head lifts and projection into the air by the male partner. Many female single skaters appear to be either overtly prepubertal and late maturing characterized by relatively longer legs and a linear physique.

Biocultural and contextual views echo the notion that individual characteristics match contextual demands. According to the biocultural view, since athletic performance includes both biological and behavioral domains, one cannot rely on a set of isolated biological or cultural characteristics for describing performance and selection. Growth, maturation and development interact to mold the individual, including self-perceptions, or self-concept. Self-concept is often affected by the child's level of biological growth and maturation (Malina and Bouchard, 1991). Successful athletic performance can also have a positive influence on self-concept (Weiss, 1991).

Being early or extremely advanced in biological maturation can affect performance and the development of self-concept. Early maturing female athletes, who are overall larger in body size than average and later maturing peers of the same age, may not have adequate psychological skills necessary for coping with both the stressors involved in the selection process of a sport and those inherent in pubertal maturation (Brooks-Gunn et al., 1985; Silbereisen et al., 1989). Increases in body size can ultimately affect performance in skating, specifically the ability to perform aerial skills such as jumps, lifts and certain spins. Being a later maturing skater may have an advantage in maintaining a smaller, more linear physique for a longer period of time during which skills are refined. Such skaters have more time to develop expertise in such skills before the body changes in size and proportions that accompany puberty occur.

Lerner's (1985) contextual view offers a further explanation of behavioral tendencies related to variation in maturational timing. Here, the 'goodness of fit' among specific physical and psychological characteristics and the demands of the context influence the valence of affect and behavior. For example, if individual characteristics and contextual demands match, positive behavior and affect will occur. In contrast, if there is a mismatch between individual characteristics, negative affect and behaviors will manifest.

Although not systematically documented, specific characteristics are favored for selection within the context of a figure skating discipline (free skating, dance and pairs). Selection is contingent on skating ability, specific bodily dimensions, characteristics of other skaters, judging criteria, and demands of coaches, parents and sport officials. For example, within the context of the pair or dance disciplines, the ideal female partner for a male skater is one who possesses similar technical abilities and body proportions. Similar proportions between male and female partners are necessary in these disciplines to create aesthetically pleasing lines which are favored by judges. Selection in both dance and pair skating is especially competitive for female skaters because they greatly outnumber available male skaters. Thus, female skaters may resort to unhealthy training and dieting behaviors to achieve or maintain a preferred physique.

Unhealthy dieting behaviors are often related to self-perceptions about physical appearance. Early adolescent girls participating in aesthetic sports, which involve subjective evaluation by others may also be at risk for developing social physique anxiety (SPA) -- anxiety that individuals experience in response to the evaluation of their physiques by others (Hart et al., 1989). It seems logical to assume that SPA would be inherent in figure skating because of the very nature of the evaluation process. Competitors who are generally equal in physical ability are subjectively compared with each other based on artistic impression, which involves physical appearance. If skaters are concerned about how others perceive their physique, they may lack confidence during performance. SPA research suggests that highly anxious individuals tend to be physically larger and use protective strategies, such as assuming shielding or unobtrusive postures (Ecklund and Crawford, 1994). If skaters have a tendency towards SPA, this behavior may inhibit the development of artistic impression and impede the likelihood of selection. The manifestation of SPA is of particular concern because it is a predictor of anorexia nervosa and bulimia nervosa (Johnson et al., 1995). Compulsive exercise and food restriction may be other strategies for meeting the demands of skating. The effects of SPA on athletes participating in subjectively evaluated movement forms needs further study because elite coaches and judges often favor linear physiques in selecting the top performers.

Girls begin to worry about their weight as early as 9 years of age (Koff and Rierdan, 1991), and early maturing adolescent girls are at higher risk for developing eating disorders (Attie and Brooks-Gunn, 1989; Graber et al., 1994). Thus, the onset of puberty and variation in pubertal timing per se may be risk factors for disordered eating (Killen et al., 1992). Such issues have prompted the American College of Sports Medicine (ACSM) to recognize that some pubertal female athletes may be at special risk for a triad of related health issues: eating disorders, amenorrhea, and osteoporosis (Yeager et al., 1993). However, the number of adolescent athletes at risk for the triad is not known. The risk for early maturers in subjectively evaluated movement forms sports may be greater, but data are presently not available. Early maturers are heavier, taller, and more stocky, on average, than chronological age peers. These factors may affect the biomechanical efficiency of skills involving rotation when they are being learned and refined, and are often aesthetically devalued in Western culture.

For many young athletes, the prerequisite physique favored by a sport and its judges is unattainable, placing them at a disadvantage in the selection process. Thus, early maturing girls may be socialized away from a sport whereas late maturing girls may be socialized into a sport, in part related to their biological lateness. In late adolescence, late maturers tend to be, on average, lighter, taller and more linear in shape than early and average maturers, and these characteristics tend to enhance performance in aesthetic sports (Malina and Bouchard, 1991). Late maturing girls may also have an opportunity to develop a level of expertise in athletic skills prior to the growth spurt and puberty (Malina, 1983). Since late maturers are older chronologically and are more linear than early maturers when they attain menarche, they may be less likely to experience SPA and related stresses. In addition, late maturers may have more time to develop the psychological skills necessary for coping with stresses inherent in some sports. Thus, if late maturing females are achieving elite status compared to early maturing age peers, they may also be distinguishable psychologically based on their psychological skills. It is possible that psychological characteristics of athletes enable them to cope better with stresses associated with physical growth and maturation, and those inherent in sport, thereby providing the means for participation at physically and psychologically appropriate levels.

Disparity between characteristics of the individual and the sport environment can affect self-concept, which may direct levels of participation, figure skating discipline involvement, and perhaps attrition. Although some research has suggested that sport participation enhances self-concept (Weiss, 1991), the subjectively evaluating context of figure skating may also have negative effects. Therefore, examining the psychobiological profiles of adolescent figure skaters may help to identify potentially successful skaters, and in particular those best suited for specific disciplines and those who may be at risk for health-related problems.

It can also be asked if the physical and psychological characteristics of successful skaters are similar across skating disciplines. If common physical and psychological characteristics can be identified in successful skaters, are they useful for selection? Physical dimensions can be reliably measured. It is also important to examine the external validity of psychological instruments by considering the correlations between subjective and objective measures. Are skater's perceptions of their physical characteristics consistent with objective physical measures? Although research has often alluded to relationships between physical variables and self-perceptions (Brooks-Gunn, 1988; Crocker and Snyder, 1996; Eklund and Crawford, 1994; Marsh, et al., 1996; Martin et al., 1997), few investigations have considered the relationships between such variables in the selection of athletes. Perhaps more critical to the health and well-being of figure skaters are the physical and psychological correlates of maladaptive eating attitudes. Are certain risk factors, such as social physique anxiety, more prevalent in particular skating disciplines or competitive contexts?

Research on figure skaters is sparse and methodologically limited. Samples are typically small and skaters are grouped across broad chronological age categories with no control for age variation in the analyses. Skaters are generally not grouped by skating disciplines and the research has not considered sub-elite and non-elite skaters. Without such considerations, information about how skaters are selected, or why they chose to participate in specific skating disciplines and competitive levels remains unclear. Although there are studies of the stresses associated with sport and the psychological characteristics of elite athletes, research has not ordinarily considered the interaction between biological maturation and psychological development (Gould et al., 1993a, 1993b; Scanlan et al., 1989a, 1989b; Smith et al., 1995).

Research on athlete selection is typically monodisciplinary. An interdisciplinary focus may provide most robust information. Educating those involved in sport, and restructuring rules and regulations within a sport (if deemed a necessity) requires an interdisciplinary focus emphasizing the integration of information from more than one subdiscipline of sport science. This is in contrast to a multidisciplinary focus, where experts from different subdisciplines work in parallel to one another rather than in symbiosis (Burwitz et al., 1994).

Research examining potential relationships among such variables is essential because athletic development occurs during pivotal points in growth, maturation, and development. Athletic development is contextually sensitive. Thus, adopting an integrated sport science approach should aid in explaining the variance in sport participation behaviors, assist in talent identification, and help educate sport officials involved in the selection process. This research may provide practitioners with information that they can use to solve sport specific problems, such as attrition, effects of rule modifications, and readiness for sport competition. In contrast, ignoring multilevel relationships may have particularly important ramifications, especially for the well-being of adolescent athletes in subjectively judged sports.

Purpose of Study

The aim of this investigation is to examine the physical and psychological characteristics of adolescent female competitive figure skaters. There are six purposes: (1) to describe the demographic, anthropometric and psychological characteristics of adolescent female competitive figure skaters as a group, and by competency level and discipline; (2) to examine the anthropometric and psychological characteristics of skaters based on menarcheal status and in relation to menarcheal timing; (3) to determine if figure skaters' perceptions of their physical characteristics are consistent with more objective anthropometric dimensions; (4) to determine if skating level and disciplinary involvement can be discriminated from a multidisciplinary composite of variables; (5) to determine if physical self-perceptions characterized by Social Physique Anxiety, Global Physical Self-

Concept, and Self-Esteem can be predicted by a unique set of physical and psychological variables; and (6) to determine if risk of eating disorder can be predicted by physical and psychological variables.

Questions and Hypotheses

Question 1

What are the anthropometric, physique, menarcheal, and psychological characteristics of female competitive figure skaters ages 11 years and older?

H1: Figure skaters are smaller in height, weight, limb circumferences and skeletal breadths, and leaner compared to reference data for non-athletes.

H2: Figure skaters are later maturing compared to reference data for non-athletes.

H3: Physical self-perceptions decrease with age, while social physique anxiety and eating disorder risk increase with age.

H4: Figure skaters will have higher PSDQ scores, and lower SPAS and EDI scores than non-athletes.

Question 2

Do the physical and psychological characteristics of competitive skaters differ across competency levels (test, pre-elite and elite)?

H5: Elite figure skaters have a unique set of physical and psychological characteristics compared to test and pre-elite skaters.

H6: There is a greater proportion of late maturing pre-elite and elite skaters than test skaters.

Question 3

Do the physical and psychological characteristics of competitive skaters differ across discipline (free skate, dance and pairs)?

H7: Dancers are older, taller and leaner and have relatively longer legs than free skater and pair skaters.

H8: Dancers and pair skaters have more favorable self-concept scores, but are at greater risk for eating disorders than free skaters.

H9: There is a greater proportion of late maturing dance and pair skaters than free skaters.

Question 4

Do the physical and psychological characteristics of figure skaters differ relative to menarcheal status and timing?

H10: Pre- and post-menarcheal skaters differ in physical and psychological characteristics.

H11: Pre-menarcheal skaters differ in physical and psychological characteristics by age group.

H12: Later maturing post-menarcheal skaters are shorter, lighter and leaner than earlier maturing post-menarcheal skaters.

H13: Earlier maturing post-menarcheal skaters report less favorable psychological characteristics than later maturing post-menarcheal skaters.

Question 5

Are the physical characteristics of figure skaters correlated with self- perceptions of physical dimensions?

H14: Anthropometric dimensions related to size, proportions and fatness are negatively correlated with selected psychological variables related to perceptions of physical characteristics, including PSDQ subscales (Body Fat, Global Physical Self-Concept, Appearance, and Self-Esteem), and positively correlated with EDI subscales (Drive for Thinness, Bulimia, Body Dissatisfaction, and Maturity Fears), and Social Physique Anxiety.

H15: Controlling for height, weight, and/or subcutaneous fatness, variables that are positively correlated during adolescence, reduces the correlations between the physical and psychological variables.

Question 6

Can a selection of physical and psychological characteristics thought to be important for the elite level of figure skating discriminate level of competency and disciplinary involvement?

H16: Physical and psychological variables can discriminate level of competency among figure skaters.

H17: Physical and psychological variables can discriminate the disciplinary involvement of figure skaters.

H18: Level of competency and disciplinary involvement are discriminated by different sets of variables in post-menarcheal figure skaters $\geq$15 years.

Question 7

Can self-concept characterized by Social Physique Anxiety, Global Physical Self-Concept, and Self-Esteem be predicted by a unique set of physical and psychological variables?

H19: Self-concept is predicted by a combination of physical and psychological variables.

Question 8

Can the susceptibility to eating disorders identified by Bulimia, Drive for Thinness, Body Dissatisfaction, Perfectionism and Maturity Fears be predicted by anthropometric characteristics, somatotype and psychological variables related to physique, appearance and self-concept?

H20: A combination of anthropometric characteristics, somatotype and psychological variables related to physique, appearance and self-concept predicts the five eating disorder subscales.

Significance

Physical evaluation is an inherent part of figure skating because up to 40% of the final score in competition is awarded for artistic impression, which involves creating aesthetically pleasing lines with the body (Canadian Figure Skating Association, 1997). Although no marks are explicitly awarded for physique, skaters having a lean and linear physique may be more aesthetically pleasing to watch than more mature skaters, and may score higher marks than more mature skaters despite having equal technical abilities. For the mature skater, these idiosyncratic evaluation criteria may reduce the probability of success. Additionally, it is assumed that a petite physique enhances the biomechanical efficiency of jumping and spinning, and thereby the talent of skaters. In an effort to maintain a favorable body composition, skaters may be inclined to train harder and decrease nutritional intakes. Such behaviors, in turn, may have health implications, in the development of eating disorders, secondary amenorrhea, and potentially osteoporosis. However, the root of eating-related problems may lie in a mismatch between the demands of the sport, which are communicated by coaches, parents, and sport officials, and the characteristics of the athlete, both physical and psychological.

A complex set of physical and psychological characteristics encompass the specific demands of a sport. Physical features include size, shape (physique and proportions), and composition, which are influenced by the timing and tempo of the adolescent growth spurt and puberty. Psychological variables include readiness for elite training and superior coping skills. A mismatch between the demands of a sport and the individual characteristics of athletes may lead to adverse consequences. For example, early maturation and inferior psychological skills can lead to concerns about weight and possibly manifestation of eating problems in an attempt to control weight. Concerns about physique may also contribute to competition anxiety and potentially influence performance (Martin and Mack, 1996). Another example is to have the appropriate size, physique and skills, but to lack the psychological skills to handle the evaluative environment.

To ensure safe participation in subjectively evaluated sports, it is important to identify the physical and psychological characteristics of competitive figure skaters who may be at risk for developing eating disorders and other health-related concerns such as osteoporosis. If skaters are at risk, programs can be designed to increase the sensitivity of coaches, parents and judges, and the sport system.

Although figure skaters have been used as subjects in sport psychology research, there is a lack of data on their growth and maturation. Research within the domains of sport psychology and biological growth and maturation rarely, if ever, consider the interaction of biological and psychological variables. Identifying relationships among these variables seems fundamental for training programs and may aid in athlete development programs. Perhaps more important to the welfare of athletes in all levels of figure skating is evaluating those who do not make it to elite status for physical and psychological variables associated with negative self-perceptions and eating disorder risk. Early maturing skaters, for example, may be predisposed to SPA, which is associated with eating disorder risk (Deihl et al., 1998).

By convention, many training programs for young athletes are based on successful programs developed for the elite, physically mature individual. It may be more appropriate to design programs that are directed at the specific needs of the younger individual and then to systematically alter the regimes as the athlete grows and matures (Klika, 1995). It has been suggested that for female figure skaters, if double jumps are not "mastered" by 12 years of age, success as an elite skater is unlikely (Gledhill and Jamnick, 1992; Ross et al., 1980b). The identification of a critical period for acquiring these skills, if such a period exists, is a challenge which has implications for scientific and practical inquiry.

Relationships between physical and psychological variables need to be conveyed to those involved in development of programs. This includes parents, coaches, judges, officials of organizations, as well as the athletes themselves. Understanding the physical and psychological development of youth and their performance can contribute to more realistic achievement expectations and more appropriate training and competitive opportunities.

Limitations

The following issues are acknowledged as limitations to the internal and external validity of this study:

1) The sample is limited to 161 volunteers 11 to 23 years of age who were recruited from 11 competitive figure skating clubs in Mid-Michigan and South Central Ontario. Generalizations to other samples of figure skaters are limited.
2) Accessibility to dancers and pair skaters was limited for two reasons. First, there are significantly fewer male skaters compared to female skaters, which restricts the number of skaters participating in the two specialized disciplines. Due to specialization, dancers and pair skaters do not participate at the test level. Second, two training centers specializing in dance and pair skating did not consent to the study
3) The nature of this study did not permit random sampling. Purposive sampling was used, which limits the generalizability of results to the current age range, competitive level, and skating disciplines.
4) Self-report questionnaire response distortion may be inherent in the context of figure skating. Skaters were informed about the nature of the study and may

have been reluctant to indicate negative eating attitudes and negative self-perceptions.

5) Pubertal status was self-reported and may not be concordant with clinical evaluation. Although clinical assessments are preferred, they are invasive to the adolescent's privacy. Self-reported pubertal status is reasonably reliable method and is often used in current studies on adolescents.

6) Coping skills were limited to the Ways of Coping Checklist. The checklist did not provide adequate subscale reliabilities for use in multivariate analyses. Therefore, presentation of coping skills results are limited to descriptive statistics.

CHAPTER II

Review of Literature

Interdisciplinary research on figure skating is limited. To understand the selection process in this subjectively evaluated sport, relationships among biological, psychological and sociological variables must be considered. A psychobiological profile of elite figure skaters may be useful for talent identification and for directing safe participation. To evaluate the likelihood of becoming an elite skater in the future, developing skaters participating at lower levels can be compared to the elite prototype. More importantly, identifying skaters with unhealthy physical and psychological characteristics, such as those associated with eating disorders, could help develop educational and/or intervention programs for athletes, parents, coaches, and sport officials.

The review considers several of the physical and psychological variables involved in athlete selection and development. First, talent identification and selection are described with emphasis on age-graded stages in the sport of figure skating. Second, the interaction between biological and psychological variables are outlined in the context of the biocultural and contextual perspectives. Third, biological variables including those related to growth, physique, body composition, and biological maturation are reviewed. Fourth, psychological variables thought to be important in the athlete selection process are examined. The concept of readiness for competitive figure skating is then discussed. Finally, relationships among biological and psychological variables are proposed to explain both the potentially beneficial and adverse effects of the figure skating selection process. Psychological risk factors, including negative perceptions of physical characteristics, social physique anxiety, and problem eating are suggested as being related to the morphological changes associated with sexual maturation.

Athlete Selection

Researchers have long questioned whether athletes excel in sports because of their individual characteristics, or if individual characteristics develop through participating in a specific sport (Carter and Heath, 1990). Does genetic predisposition to particular traits determine performance? Or, does training alter individual characteristics to conform to the demands of the sport? Evidence suggests athletic performance is influenced by both factors.

The process of identifying talented individuals for a given sport begins in childhood (Bompa, 1985; Ericsson et al., 1993; Malina, 1994; Scanlan et al., 1989a). The progression from initial youth sport experiences to more elite levels involves complex identification and selection criteria encompassing skill, physical and behavioral prerequisites. As some programs become more competitive and specialized, criteria tend to be sport-specific. Talent identification and selection occur both formally and informally. For example, identification occurs informally during practice or competitions where skilled participants are invited to tryout for elite teams. In contrast, formal identification occurs during organized tryouts which involve more specific evaluation of physical and behavioral characteristics.

The trend in selecting figure skaters seems to parallel recent trends in gymnastics and ballet. Intensive training in these sports characteristically begins at an early age and is contextually sensitive. Athletes competing at elite levels are younger in chronological age than athletes competing in other sports and appear to be biologically immature (Malina, 1994). However, at all levels of age-based competitive categories, young athletes are expected to perform more difficult skills than past competitors.

In both figure skating and gymnastics, it is common to take a potentially talented athlete to a talent identification center to seek the advice of sport officials (Malina, 1997; Starkes et al., 1996). Although national and junior national skaters undergo fitness testing (Gledhill and Jamnick, 1992; Starkes et al., 1996), it is not known with certainty if talent identification officials base their criteria on contemporary scientific research. Bompa (1985) recommends the following criteria for systematic selection: (a) assessment of overall biological health, (b) ongoing assessment of biometric or anthropometric qualities of physical growth, (c) assessment of hereditary factors to determine the probability that the individual has overall physiological capacity, (d) assessment of environmental factors such as the availability of training facilities, and (e) availability of specialists for proper coaching. According to Bloom (1985), commitment and dedication to an activity increases over the progression of three involvement periods labeled the early, middle and later years. In a study of former elite figure skaters, the average amount of time spent in each of these phases was 2.9 ± 1.5, 4.0 ± 1.7, and 6.0 ± 2.4 years, respectively (Scanlan et al., 1998a)

Starkes et al. (1996) plotted the age and number of years of deliberate practice required to attain each successive competitive level of skating. The years of practice for 20 members of the Canadian national figure skating team (12 males and 8 females) from preliminary to gold (elite) test levels, were plotted. With age as the predictor, the regression equation was $y = 0.51x - 2.428$, $r = 0.88$ and $r^2 = 0.77$. Age at attainment of the gold test level was 18.3 ± 0.9 years. With years of experience as the predictor, the equation was $y = 0.441x + 1.087$, $r = 0.81$ and $r^2 = 0.66$. Age at attainment of the gold test level for this group required 11.2 years of practice and experience.

Elite and expert performances are treated synonymously in the talent identification literature. Ericsson et al. (1993, see also Ericsson and Charness, 1994; Ericsson, 1996) suggest that it is not individual trait differences that determine successful performance. Instead, a deliberate decision to invest a considerable amount of time, often a minimum of 10 years, is what discriminates more successful athletes from other participants. Ericsson and Charness (1994) suggest that expert performances are mediated by acquired complex skills and physiological adaptations due to high levels of deliberate practice sustained over a decade or more. This view appears to exclude the minimum necessary physical prerequisites for a given sport. For example, it is hard to imagine a successful female gymnast who is 185 cm tall. Ericsson et al. (1993) agree with Bloom (1985), who found that successful performers are willing to invest great amounts of time and effort to accomplish their goals. Ericsson et al. (1993, p. 400) further suggest that "the commitment to deliberate practice distinguishes the expert performer from the vast majority of children".

Although there is no minimum age requirement to begin skating lessons, initial exposure to skating lessons usually begins between 3 and 7 years of age (Canadian Figure Skating Association, 1997). At this stage, practice consists of learning basic skating skills in group lessons, usually once per week, while other activities and sports may also be practiced (Scanlan et al., 1989a). Individual testing of skills comprising specific developmental levels is also done in a group format and occurs approximately every four weeks during a season.

Comper (1991) proposed a hypothetical, three-stage model of talent identification for Canadian figure skaters depicted by consecutive, overlapping circles (Figure 1). The first stage of the model is 'the pre-selection or detection stage' between 7 and 11 years. Important characteristics at this stage include: (a) ability to learn technical skills faster than peers, (b) willingness to work for longer periods of time than peers, (c) a high degree of physical flexibility, (d) excellent balance and coordination, (e) a marked sense of control over the environment, and (f) a high level of self-confidence.

The secondary stage of the selection process occurs sometime between 11 and 15 years of age when further specialization takes place. In the intermediate stage, children begin private lessons, are tested on an individual basis, and experience an increase in skating and skating-related activities (Scanlan et al., 1989a). Elite figure skaters practice an average of 22.2 hours per week (Starkes et al., 1996). Comper (1991, p. 178) refers to this stage as 'the first phase of selection' and advocates that coaches assess biological characteristics, psychological skills, and technical physical skills. However, for those skaters participating at the club level, access to coaches who are knowledgeable in assessment procedures and criteria is questionable. Several characteristics were advocated by Comper: (a) specific physical characteristics including a muscular build with narrow hips, and small body size (height and weight), (b) strength, explosive power and speed of movement, (c) balance and gross and fine motor coordination, (d) rotational preference and lateralized behaviors, (e) strong motivation to achieve success and avoid failure, (f) high level of perceived self-competence, (g) high self-esteem, and (h) low levels of pre-competition anxiety.

Technical testing at this level entails movements performed to music, often while the child is the lone skater on the ice. Competitive events are sanctioned in age-based categories. Skaters perform in skating costumes which do not conceal their physiques. For both test and competition, merit is given for artistic impression, which is partially comprised of subjective evaluation of body form.

The third stage of selection is the novice Competitive and above. Skating becomes more exclusionary as competition becomes more specialized and rigorous. Skating takes up almost all of the skater's time and usually requires a substantial financial commitment (Scanlan et al., 1989a). Skaters with superior jumping ability excel in singles events, and female skaters possessing physical characteristics (height, weight and skating abilities) which match those of a limited number of male skaters may be selected for pair skating. Dancer pairs must also possess matching physical characteristics to some extent.

Provincial competitions in Canada begin at the pre-novice level. Age eligibility for competing at this level for singles skaters is $\leq$14 years for females and $\leq$15 years for males, while male and female pairs and dance skaters must be $\leq$17 years. There are no age restrictions for national competitions at the junior and senior levels (Canadian Figure Skating Association, 1997). Selection for elite competition, defined as junior and senior Competitive levels, occurs in the context of a variety of criteria, including economic status, physical characteristics, biological maturation, and psychological readiness (Comper, 1991; Gould et al., 1993a, 1993b; Scanlan et al., 1989a, 1989b).

The third stage in Comper's (1991) model is the advanced level which is limited to skaters 15 to 18 years. Skaters at this stage are to as pre-elite. For skaters to become 'truly elite', additional characteristics include: (a) high aerobic and anaerobic capacities, (b) low percentage of body fat, (c) high power to weight ratio, and (d) memory of complex movement patterns. The progression of stages, depicted by the overlapping sections in Figure 1, becomes notably smaller as the selection phase continues. As the criteria become more stringent, fewer skaters move towards elite status.

A fundamental limitation of the model shown in Figure 1 is lack of specificity. Although a variety of talent indicators are mentioned, no specific parameters for biological or psychological variables are stated. The model is thus of limited utility for coaches who are often unfamiliar with specific features of growth and maturation of young athletes, which can vary extensively at each stage of the model. Biological characteristics vary not only by sex, but by maturational status and pubertal timing. The model also provides limited information on how to measure the indicated psychological characteristics and whether the available instruments are age appropriate. Nevertheless, talent identification clearly relies on the interaction of biological and psychological characteristics; one cannot exist without the other. Yet, the majority of research, particularly in the domain of psychology, has followed monodisciplinary methodological designs (Burwitz et al., 1994). The value of such unidimensional research is thus limited for athlete identification and selection.

Biological Variables in Figure Skating

Many researchers have focused attention on the characteristics of elite athletes. This information is often used for developing a prototype to which characteristics of future athletes can be compared (Comper, 1991; Gledhill and Jamnick, 1992; Woodman, 1985). Many of these studies consider young adult athletes in a sport, while relatively few consider elite athletes in terms of growth, maturation, and physique. Growth refers to increases in size of the body or its parts, including changes in body composition, physique and specific body systems (Malina and Bouchard, 1991). Biological maturation refers to the tempo and timing of progress towards the mature state. Maturational indicators most often include skeletal age and secondary sex characteristics (Malina and Bouchard, 1991).

Anthropometry is central to quantifying growth status. It serves to describe the morphological status of an individual or a sample, or as a basis for comparison of a sample to the population or to other samples. Anthropometry involves the use of carefully defined body landmarks for dimensions, specific subject positioning for the measurements, and the use of appropriate instruments. Measurements are generally divided into mass (weight), lengths and heights, breadths or widths, circumferences or girths, and skinfolds (Malina, 1995).

Growth Indicators

Body Size

The most common anthropometric dimensions considered in athletes are stature and weight. Stature increases in both sexes from infancy through childhood with marked acceleration during adolescence. It reaches a plateau, on average, at approximately 16-17 years in girls and 18-19 years in boys. Weight follows a similar pattern, but continues to increase into adulthood (Malina and Bouchard, 1991).

Data for stature and weight of figure skaters are somewhat limited and rarely include athletes across a broad age range. To date, cross-sectional data suggest that figure skaters are generally shorter and lighter than U.S. reference medians (Malina, 1994). A summary of anthropometric research on figure skaters is presented in Table 1. Weight, stature and sitting heights of 11 year old elite figure skaters (n = 18) were significantly lower than those of 11 year old female non-skaters (Ross et al., 1980b). In a study of 25 elite figure skaters 14-18 years of age, mean height and weight were 160.0 $\pm$ 6.0 cm and

48.2 ± 5.6 kg, respectively (Brooks-Gunn et al., 1988). More recently, 28 female novice, national competitors with a mean age of 14.0 ± 1.7 years, had a mean height of 157.6 ± 7.4 cm and a mean weight of 48.1 ± 7.6 kg (Comper, 1991). These skaters were slightly older, taller and heavier compared to an earlier study of skaters with a mean age of 13.2 ± 1.4 years (height: 153.5 ± 8.4 cm; weight: 42.1 ± 5.4 kg; Ross et al., 1977). Finally, Ziegler et al., (1998) reported an average height of 158.7 ± 7.5 cm and average weight of 50.3 ± 8.4 kg for competitive female adolescent figure skaters, with a mean age of 13.7 ± 1.4 years.

The predictive utility of stature and weight for performance is inconclusive, but both dimensions may be used in screening young skaters. In a sample of nine elite skaters, shorter, leaner skaters had better performance records (Niinimaa, 1982). In another study of 44 novice figure skaters (28 females, 16 males), the individual predictive contribution of stature and weight to performance was negligible (Comper, 1991). However, a composite of variables including stature, weight and other dimensions (calf, thigh and leg lengths, waist and buttocks circumferences; and sitting height) accounted for 56% of the variance in performance of females (number of points obtained for competition placement during the 1986-1987 season). These variables accounted for 93% of the variance in males (Comper, 1991). Unfortunately, these results have limited utility given the small number of participants (n = 28 females, n = 16) relative to the number of variables (2 ratios and 10 dimensions) in the analyses. Furthermore, age, which most likely reflects experience, was not included in the analyses. It is interesting to note, however, that all of the athropometric variables correlated negatively with performance perhaps suggesting that smaller skaters did better.

Gymnasts and figure skaters of both sexes are the only young athletes who present a profile of short height for age compared to non-athletic children (Malina, 1996). As in gymnastics, the size of figure skaters must be considered in the context of the extremely selective criteria applied at early ages. Selection in figure skating, and perhaps exclusion, is based on small body size and a slender, yet muscular build. Although there are no available data specifically on figure skaters, selection in gymnastics and swimming appear to be based on familial, presumably genetic factors. There are moderate to high correlations between the height of prepubertal Dutch gymnasts and the height of their mothers: recreational gymnasts ($r = 0.72$), young talented gymnasts ($r = 0.63$) and older talented gymnasts (0.92). In contrast, the height of swimmers is more correlated with height of their fathers ($r = 0.87$) (Peltenburg et al., 1984).

It is suggested that small and muscular female single skaters have a biomechanical advantage in figure skating (Ross et al., 1977) because they possess a greater moment of inertia required in rotation (Harris, 1986; Niinimaa, 1982). The size advantage for individuals with smaller stature is explained by a high strength-to-weight ratio (Niinimaa, 1982). A lower center of gravity is another suggested advantage for balance and aerial rotation involved in figure skating. This is conventionally expressed by absolute estimated leg length (stature minus sitting height) and relative leg length (sitting height/stature ratio). To date, only Comper (1991) has considered sitting height and leg length, albeit unconventionally. Comper's (1991) method of measuring these dimensions is not sufficiently clear. Sitting height was described as "trunk height: Measured from the top of the head to the pelvic bone" (p. 104), and leg length was labeled "stem height: Measured as the length from the hipbone to the floor, with subject standing" (p. 104). The specific landmarks not indicated. Although Comper (1991) did not use conventional anthropometric methods to measure sitting height or absolute leg length, the latter could be derived by subtracting "trunk height" (71.3 $\pm$ 4.7cm) from stature (157.6 $\pm$ 7.4 cm). Following this method, the average estimated leg length of female novice skaters was 86.3 cm, which is higher than the reported stem height value (74.6 $\pm$ 4.7 cm). Relative leg length, derived by dividing trunk height by the derived estimated leg length, was 45.2%, which would suggest relatively longer legs (Comper, 1991). Given the methodology, it is impossible to compare these data with other data since sitting height is measured differently and leg length is conventionally estimated by subtracting sitting height from standing height (Malina, 1995).

Another expression of body size encompassing weight and height is the Body Mass Index (BMI: wt(kg)/stature (m^2). Only one study of figure skates has specifically referenced the BMI. Female novice singles, pairs and dance skaters, 12-17 years, had a mean BMI of 19.2 $\pm$ 2.1 kg/m^2 (Comper, 1991). There are two limitations of using the BMI with adolescent figure skaters. First, the relationship between stature and weight is temporarily altered during puberty, when the growth spurt occurs (Malina, 1995). Providing data for single year age groups would have been more meaningful. Second, cross-disciplinary composition of groups is inappropriate since it may conceal differences among disciplines. The BMI must also be interpreted with caution with athletes. It does not separate fat mass from fat-free mass. Accordingly, athletes who are generally more muscular may appear to have higher BMI values.

Body Composition

Body composition refers to the primary tissue components of body mass. Body weight is a composite of different tissues including bone, muscle, fat, and the viscera. It is often described in the context of a two-compartment model which partitions body mass into its lean and fat components: fat-free mass (FFM), and fat mass (FM). The focus with many female athletes is usually FM because dietary and exercise habits can influence this component and because of the emphasis on fatness in Western culture. The FFM does not distinguish between specific tissues such as bone, muscle and the viscera. Another limitation of this model is the lack of information concerning regional distribution of tissues. Such information may be important for studying compositional variation between the trunk and extremities, and sex differences associated with growth and maturation. Differential distribution of fat, muscle and bone is not reflected in the two-component model (Malina and Bouchard, 1991).

Between the ages of 8 and 18 years, children increase in both FFM and FM. However, female athletes do not increase in FM as much as representative samples of non-athletes (Malina and Bouchard, 1991). Girls show a lesser gain in FFM than boys during adolescence. Estimated FFM of late adolescent girls is approximately two-thirds of the estimate for boys (Malina and Bouchard, 1991).

A common method of representing subcutaneous fatness is the sum of several skinfolds. In a study of 28 novice female figure skaters, with a mean age of 14.0 ± 1.7 years, the sum of 6 skinfolds was 53.0 mm (Comper, 1991), which is lower than results (58.0-75.4 mm) gathered at the Canadian fitness testing center for the 1991 World and national team (Gledhill and Jamnick, 1992). Contrary to the majority of research on figure skaters, Gledhill and Jamnick (1992) provided a cross-disciplinary comparison of fitness test results. For both World and national discipline-specific team samples, single skaters (75.4 mm, 76.6 mm, respectively) had a greater sum of 6 skinfolds than dancers (70.8 mm, 73.9 mm, respectively), who had a larger sum than pair skaters (63.8 mm, 58.0 mm, respectively). Additionally, all World and national discipline-specific groups had greater sums than the values 'recommended' by the fitness testing center ($\leq$ 60.0 mm for females), with the exception of national level pair skaters (58.0 mm). Measurement variability for the skinfolds was apparently not considered in this study.

According to Gledhill (1976), 9-11% body fat is desirable for female skaters, and 7-8% is desirable for male skaters which was slightly lower than what was recommend for non-skaters in the same age group (13 - 18 years). "The purpose of the body fat assessment was to determine whether the skater was overweight. Not overweight by normal standards, but in consideration of the fact that appearance is extremely important in the judging of aesthetic sports" (Gledhill, 1976, p. 10). Comper (1991) reported 8.8% as the mean estimated percentage body fat predicted from six skinfolds (subscapular, triceps, iliac crest, abdominal, front thigh, and rear thigh) using the 'Yuhasz (1980) method' in novice female skaters. Using the same method, Gledhill (1992) reported 11.1%, 10.8%, and 9.3% for national level singles, dance, and pair skaters, respectively. However, the equation is based on college students, and may not be applicable to adolescent skaters. Mean ages were not provided for the groups.

One recent study on figure skaters report considerably higher percentage body fat than recommended by Gledhill (1976). Ziegler et al. (1998), reported a mean of 19.9% (range 13.1% - 27.8%) which was within the range for female athletes 13 years of age

(17% - 25%, Steinbaugh, 1984). A limitation of this study is the cross-disciplinary combination of subjects and failure to consider maturational variation. The sample included elite adolescent skaters without controlling for maturity status.

A related issue is the reporting of fatness data to the athletes, specifically females. For example, "...following each session, scores were provided to each skater, their coach and the CFSA. In addition, skaters received a summary of average scores from all national team members" (p. 6, Gledhill and Jamnick, 1992). Recommending lower than "normal" are percentage fat and sum of skinfold values may be stressful for adolescent athletes and should be accompanied by educational information explaining normal variation during adolescence and the limitation of skinfolds.

Compared to other athletes, figure skaters appear to be most similar to gymnasts (Claessens et al., 1992; Bernink et al., 1983; Peltenburg et al., 1984; Theintz, et al., 1994) and ballet dancers (Brooks-Gunn and Warren, 1988) in height, weight, BMI, and estimated body composition. However, age specific comparisons are difficult since athletes in these sports are not consistently grouped by age.

Physique

Physique refers to an individual's body form, or the configuration of the entire body rather than of specific features (Malina, 1995). The method of assessing physique most commonly used with athletes at present is the Heath-Carter anthropometric protocol. The Heath-Carter method defines somatotype as "a quantitative description of the present shape and composition of the human body" (Carter and Heath, 1990, p. 15). It involves a 3-number rating system derived from several anthropometric dimensions. The components of a somatotype are endomorphy (relative fatness), mesomorphy (relative muscularity), and ectomorphy (relative leanness). The three components are regarded as a single unit which describes an individual's somatotype. For example, when estimating the relationship between ectomorphy and endurance performance, the other two components should be statistically controlled.

There are limited somatotype data for figure skaters, and cross-disciplinary comparisons are not ordinarily made. A summary of somatotype data for figure skaters is presented in Table 2. Carter and Heath (1990) include data from four studies conducted nearly three decades ago. At that time, mean somatotypes varied between 2-4-4 and 3-4-3. Evidence suggests that the distribution of somatotypes of young athletes parallels that of older athletes in the same sport (Carter and Heath, 1990). However, somatotype changes somewhat with growth and maturation as evident from the change in pre- to post-puberty among elite female skaters. The data suggest an increase in endomorphy and mesomorphy and a decrease in ectomorphy. The mean somatotype for prepubertal female figure skaters was 1.8-2.3-3.3 compared to 2.4-3.4-2.8 in postpubertal skaters. Prepubertal skaters appear to be somewhat meso-ectomorphic, whereas postpubertal, skaters appear to be slightly more mesomorphic (Weaver and Thompson, 1981). Ross et al. (1980b) reported a somewhat similar mean somatotype of 2.6-3.8-3.0 in 18 postpubertal figure skaters.

Compared to skaters, elite gymnasts show little variation in somatotype with age and are especially low in endomorphy and higher in mesomorphy (Claessens et al., 1992; Salmela et al., 1979; Yuhasz et al., 1980). Mean somatotypes for young gymnasts are near 2-4-3, and older samples have a more balanced somatotype near 3-4-3 (Carter and Heath, 1990). In contrast, adolescent ballet dancers are somewhat higher in ectomorphy (Claessens et al., 1987), with means near the 3-3-4 range. Junior Olympic divers are mesomorphic, and mesomorphy increases with age, especially in late adolescence. Like gymnasts and skaters, divers are in the 3-4-2 range, more mesomorphic and less endomorphic than non-athletes (Geithner and Malina, 1993). In general, skaters most resemble gymnasts and divers, but the somatotype data available for figure skaters is restricted to novice athletes. Data for elite and sub-elite samples are apparently not available.

Maturation

Maturation refers to progress towards a mature state; progress that can be characterized in terms of timing (when things occur) and tempo (rate at which they occur). Very often adolescents are arbitrarily grouped as early, average, and late maturers on the basis of the age at peak height velocity, the timing of appearance of secondary sex characteristics, or age at menarche in girls. In the United States, menarche occurs on average at 12.8 ± 1.0 years (Eveleth and Tanner, 1990), but can occur as early 9 years and as late as 17 years (Brooks-Gunn, 1988). The timing of menarche is often used to classify girls as early, average and late maturers. Girls attaining menarche prior to 12.0 years of age are generally considered as early maturing, those attaining menarche between 12.0 and 14.0 years are considered average or 'on time', and those attaining menarche older than 14.0 years are considered late maturing.

Menarcheal data on figure skaters has been considered in several studies (Table 3). Most recently, Ziegler et al. (1998) reported 12.4 as the average age of menarche in a sample of 17 competitive figure skaters with a mean age of 13.7 years. This age contrasts the evidence from skeletal and sexual maturation, which suggests later maturation in female figure skaters (Brooks-Gunn et al., 1988; Malina, 1994). Mean retrospective ages at menarche in earlier studies of figure skaters ranges from 13.6 - 15.4 years, suggesting later maturation (Brooks-Gunn et al., 1988; Ross et al., 1980a; Wells and Plowman, 1988). Ross et al. (1980a) reported 14.0 years as the mean recalled age at menarche in sample of 18 figure skaters. However, three skaters in this sample, 13.1, 14.7, and 15.9 years, had not yet experienced menarche so that the mean may be later. In another study, the mean age at menarche was 13.6 $\pm$1.5 years in a sample of 25 skaters (Brooks-Gunn et al., 1988). These estimated ages at menarche are based on the retrospective method and thus may have variation associated with memory in recalling the exact age. Further, some estimates are probably low due to the number of pre-menarcheal skaters in the sample.

Like skaters, gymnasts, divers and dancers also attain menarche later than non-athletes. The estimated median ages at menarche in elite female gymnasts was 15.6 years (Claessens et al., 1992), and in Junior Olympic divers was 13.6 years (Malina and Geithner, 1993). These two studies are based on the status quo method, which is an estimate for the samples based on probit analysis. Ballet dancers are frequently cited as examples of girls with late menarche. In one study of 15 ballet dancers, the mean age at menarche was 15.4 years and two dancers in this sample did not attain menarche until 18 years (Warren, 1980).

A combination of genetic and environmental factors is thought to regulate the age at menarche. Evidence suggests that menarcheal timing is genetically programmed (Brooks-Gunn, 1988; Brooks-Gunn et al., 1988; Claessens et al., 1992; Malina, 1983, Malina et al., 1994). Genetic regulation of menarcheal timing is inferred from correlations between mother-daughter and sister-sister pairs, but earliness and lateness can also be inherited from the father. Correlations for ages at menarche range from 0.15 to 0.40 for mother-daughter pairs, and 0.25-0.61 for sister-sister pairs (Malina et al., 1994). However, since mothers and daughters share only one-half of their genes these correlations are expected. Familial resemblance in age at menarche in athletes, their sisters, and mothers, is consistent with that of the general population indicating that later menarche commonly reported in athletes is largely familial and presumably genetic. Yet, in a mother-daughter comparison of dancers and non-athletes, dancers had later age at menarche compared to non-athletes, but there were no differences between ages at menarche in the mothers of the two groups. These authors interpret this observation as suggesting that later menarche in athletes may not be entirely genetic (Brooks-Gunn et al., 1988).

Data on mother-daughter similarities in age at menarche among figure skaters are apparently not available. The most commonly cited environmental factor in the sport science literature that is associated with later menarche in athletes is training (Wells and Plowman, 1988), and there appears to be an association between later age at menarche and more advanced competitive levels within some sports (Malina, 1983). The data are correlational and do not imply cause and effect. Although menarche occurs later in athletes than in non-athletes, evidence suggesting that exercise delays menarche is inconclusive because there are too many confounding variables that are not controlled (Clapp and Little, 1995; Loucks et al., 1992). In addition to quantifying an controlling the type, intensity, and duration of exercise, Loucks et al. (1992) recommend considering the gynecological age of the participants.

In sum, weight gain occurs in both sexes during puberty, but increase in muscle tissue accounts for most of the male weight spurt, while accumulation of adipose tissues accounts for a significant portion of the gain in females. Girls experiencing early maturation may not be psychologically prepared to deal with the associate physical changes which separate them from their peers (Brooks-Gunn et al., 1985). If negative self-perceptions are associated with maturation, they may subsequently affect the level of self-confidence that is essential for the artistic impression required in figure skating. Since smallness, leanness and linearity are related to later maturation, later maturation may be a physical and psychological advantage for adolescent figure skaters.

Psychological Variables

The talent detection literature suggests that certain psychological traits are determinants of future success in sport. In summarizing studies of athletes in different sports, as well as different age groups, self-motivation, goal orientation, intelligence, anxiety, neuroticism, and particularly, self-confidence, stubbornness, emotional stability and ambition can discriminate between successful and less-successful athletes (Gould et al., 1981; Mahoney, 1989; Mahoney, et al., 1987; Missoum and Laforestrie, 1985). Of the above traits, the following are the most frequently cited in the literature: high self-confidence, low anxiety, high number of anxiety coping strategies (emotional stability), and increased concentration on tasks (Vanden et al., 1993). The variety of psychological predictors indicates the need for several psychometric instruments since no currently available tool can assess all of the above.

Qualitative analyses have identified several psychological factors thought for be important to success in competitive figure skating. Scanlan et al. (1989b) interviewed national level skaters concerning sources of enjoyment and stress. Among former elite figure skaters there were four major sources of enjoyment: (a) social and life opportunities; (b) perceived competence; (c) social recognition of competence; and (d) the act of skating. Sources of stress for elite figure skaters included: (a) negative aspects of competition (e.g., worries about failure); (b) negative significant-other relationships (e.g., skating politics); (c) demands and costs of skating (e.g., financial and time demands); (d) personal struggles (e.g., weight problems, self-doubt about talent), and (e) traumatic experience (e.g., death of a loved one).

Gould et al. (1993a, 1993b) also interviewed national champion figure skaters about experiences in two phases of their careers: when they first began skating at a senior level until they won a national championship, and the time from first winning the national championship until either the present time or the of retirement as an amateur skater. General sources of stress were similar across both phases. The positive experiences of U.S. national champions included: (a) positive emotional experience at national championships; (b) positive effects of winning/defending on self-esteem; (c) national champion perquisites; and (d) positive affect and growth in self-awareness from losing a title (Gould et al., 1993b). In contrast, negative experiences were: (a) high performance standards based on expected potential; (b) environmental demands on skater resources; (c) competitive anxiety and doubt; (d) stresses related to significant others; and (e) demands on financial resources (Gould et al., 1993b).

These studies provide reasonably robust information about the elite figure skating experience. Rather than identifying symptoms of stress, emphasis is on identifying sources of stress. While the studies are valuable in preparing skaters for sources of stress at the elite level, they are retrospective and thus provide limited information about stresses involved in the process of becoming elite. Young figure skaters encounter a variety of stresses throughout the developmental process, and many sources of stress entail social evaluation. Social evaluation is integral to competitive figure skating; it is the basis of ranking performances. Social evaluation comes from a variety of sources. It is obviously a part of competition. It also occurs indirectly at training centers, in the dressing room, and even at home. Negative evaluations come from judges and coaches, who serve as the gate keepers of talent identification. Skaters also receive information about their skating abilities from parents, other skaters, and even parents of skating peers. Without superior psychological skills, such an environment can negatively impact the way young skaters perceived themselves.

Self-concept

Self-concept is a person's perceptions of self, formed through experiences and with interpretations of one's environments. It may pertain to physical, intellectual, or social characteristics. It is especially influenced by evaluations of significant others and reinforcements and attributions for one's own behavior and accomplishments.

Self-concept was once regarded as a global construct that did not differentiate between perceptions of physical, social, academic and other dimensions of self. Currently, self-concept is viewed as a multidimensional hierarchical construct (Shavelson et al., 1976). Each level of hierarchy is divided into domain-specific components of self-concept.

The Physical Self-Description Questionnaire (PSDQ) distinguishes specific aspects within the physical domain (Marsh et al., 1994). It measures nine specific components of Physical Self-Concept: Strength, Body Fat, Activity, Endurance/Fitness, Sports Competence, Coordination, Health, Appearance, Flexibility, and two global components: Self-Esteem and Global Physical Self-Concept. Among the multiple domains of self-concept, the physical appearance component of physical self-concept is most highly correlated with Self-Esteem (Marsh and Roche, 1996).

A positive self-concept is widely recognized as an important outcome of sport and as a means to facilitate other desirable outcomes including success in sport (Marsh et al., 1997). Psychologists have employed the PDSQ with athletes in several sports - basketball, tennis, volleyball, gymnastics, diving, swimming, synchronized swimming, soccer and softball (Crocker and Snyder, 1997) and in water polo, track and field, basketball, soccer, cycling, swimming, baseball, rugby, netball, cricket and aerobics (Marsh et al., 1997). Descriptive statistics for athletes and non-athletes are presented in Table 4. Athletes generally report higher PSDQ subscale scores than non-athletes, and elite athletes report higher scores than non-elite athletes.

Vealey (1986) suggests that positive self-evaluations may provide a competitive edge among elite athletes. However, self-concept formation depends upon the frame of reference. Two models have been postulated for explaining self-concept formation. Although these frames of reference are derived in academic settings, it is reasonable to assume that a similar process occurs in athletic settings. Athletic scenarios are provided subsequently to illustrate the two models of self-concept formation.

According to the internal/external frame of reference (Marsh, 1993), the formation of specific self-concepts involves comparing one's skills with the skills of others (an external social comparison process), and one's competence in a specific area with competence in other areas (an internal social comparison process). Sub-elite athletes (water polo, basketball, soccer, cycling, swimming and baseball) attending an athletically selective school had lower Physical Self-Concepts than athletically equivalent students attending an athletically non-selective school (rugby, soccer, netball, track and field, cricket aerobics netball, swimming, rugby, volleyball) (Marsh et al., 1997).

Similar to the external comparison process, Marsh (1991) described another frame of reference called the "big-fish-little-pond effect" where students matched in terms of academic ability have lower academic self-concepts when they attend academically selective schools (where other students are also bright) in contrast to academically non-selective schools. Although this effect has yet to be tested in the athletic context, Marsh et al. (1997) predict that non-elite athletes attending an athletically selective high school would have lower Physical Self-Concepts than athletically equivalent students attending an athletically non-selective school. Even sub-elite athletes may have average, or above-average, self-concepts about their best athletic skill not because they are exceptionally proficient in that skill, but because they are better in that skill than in other skills. Similarly, elite athletes, who practice with elite competitors having similar sport skills, may have only average self-concepts in their weakest sport skill even though their skills are better than those of most other athletes (Marsh et al., 1997).

Adolescence requires individual adjustments to physical and psychological changes. The biological changes associated with maturation apparently place a heavier burden on female than male adolescents in Western culture, because thinness is a cultural standard of feminine beauty (Casper and Simon, 1997). Despite this common assertion, little is known about the body satisfaction of female adolescent athletes. Equations to predict self-concept, particularly Marsh's (1996) Global Physical Self-Concept and Self-Esteem, have typically focused on psychological predictors dealing with perceptions of physical characteristics such as body fat and appearance (Crocker and Snyder, 1997), and have not considered more objective measures of physical characteristics such as physique. More research is needed to test the concordance between actual and perceived physical characteristics. Further, objective measures of physical appearance such as weight, body composition, and somatotype may help to explain variance in physical self-perceptions.

Social Physique Anxiety

Requirements for thinness may go beyond what is necessary for athletic performance, becoming an aesthetic preference (Brooks-Gunn et al., 1988; Gledhill, 1976; Swoap and Murphy, 1995). In this context, a series of studies have considered social physique anxiety (SPA) - anxiety that individuals experience in response to others' evaluations of their physique. Although physique refers to overall body form and structure of the body among human biologists, the concept of social physique anxiety was developed based on Schilder's (1935) definition of body image - the picture of the body which individuals form in their mind (cited in Schlenker, 1980). SPA was derived for the exercise context and was based on earlier research on self-presentation, the process of controlling and monitoring how one is perceived by others.

Hart et al. (1989) developed the Social Physique Anxiety Scale (SPAS), a 12-item self- report instrument. To establish criterion-related validity, hierarchical multiple regression analysis was conducted to determine if SPA predicted reactions to being evaluated beyond more subjective measures which included indices of "physique" and fitness. The physique measure was percentage body fat, but the method of estimating body fat was not stated. Weight, percentage body fat, and body self-rating accounted for 10% of the variance in self-reported stress during the evaluation and SPA accounted for an additional 23% of the variance.

The psychometric properties of the SPAS have been questioned, specifically whether it is multidimensional or unidimensional. In a double cross-validation study, Eklund et al. (1996) confirmed a two-factor structure representing physique presentation comfort (PPC) and expectations of negative physique evaluation comfort (NPEC), both of which are subordinate to a second order factor, SPA. However, this factor structure was dismissed due to a number of conceptual and empirical weaknesses (Martin et al., 1997). Nine of the original 12 items presently comprise the SPAS. The remaining three items (2, 5, and 11) were deleted making this version of the SPAS more parsimonious than the two-factor model (Martin et al., 1997).

Several investigations have examined SPA in adults in exercise settings (Hart et al., 1989; Johnson et al., 1995), in adolescent athletes (Crocker and Snyder, 1997; McAuley and Burman, 1993; Reel and Gill, 1996), and in adult athletes (Martin and Mack, 1996). Descriptive statistics for four studies are presented in Table 5. Item means range from 2.4 to 3.4 on the 5-point scale. Adolescent female athletes in several sports (basketball, tennis, gymnastics, volleyball, swimming, soccer, softball) report lower values (Crocker and Snyder, 1997) than elite gymnasts (McAuley and Burman, 1994) and non-athlete young adult females (Eklund and Crawford, 1994; Hart et al., 1989).

SPA is associated with exercise behavior. Self-presentational reasons such as body tone, weight control, and physical attractiveness are positively associated with SPA (Eklund and Crawford, 1994). Adult females with high SPA are uncomfortable in and avoid situations involving physical self-presentation (Hart et al., 1989). There is also a negative relationship between SPA and exercise experience in adult females (Hart and Gill, 1993). A study of female college exercisers showed that SPA is positively associated with estimated percentage body fat (Eklund and Crawford, 1994). Percentage body fat was estimated from body density which was predicted using three separate equations appropriate for the population (Sloan et al., 1962; Pollock et al., 1980). The equation of Brozek et al. (1963) was used to estimate percentage body fat from body density. Percentage body fat and weight control reasons for exercise accounted for 39% of the variance in SPA in this sample.

SPA might be expected in athletes participating in aesthetic sports given the important role of subjective evaluation (Crocker and Snyder, 1997; Martin and Mack, 1996; Martin, et al., 1997; McAuley and Burman, 1993). In such sports, physical self-presentation may be of greatest concern because evaluation of physique may influence sport outcome (Martin and Mack, 1996). Further, SPA is predictive of competitive trait anxiety in adult female athletes participating in hockey, soccer, volleyball, track and field, gymnastics and figure skating, suggesting that SPA may be an influence in competitive performance (Martin and Mack, 1996). Similar to many sport psychological research, sport-specific scores were not reported.

Low self-esteem, unfavorable perceptions of body weight, and heightened awareness of public aspects of the body predicted SPA in female soccer players, gymnasts, and figure skaters (Martin et al., 1997). Interestingly, both figure skaters and gymnasts reported lower SPA scores than soccer players. This was somewhat surprising because performance outcome in both figure skating and gymnastics involves subjective evaluation. The low SPA among gymnasts and figure skaters was attributed to low estimated percentage fat (13.0 % and 15.1%, respectively), calculated from body density using standard age-specific equations (Lohman, 1989). Individuals with low relative body fat (Eklund and Crawford, 1994; Hart et al., 1989; Petrie, 1996), or those with favorable perceptions of their body fat, as reported for some adolescent athletes participating in basketball, tennis, gymnastics, volleyball, synchronized swimming, speed swimming soccer and softball (Crocker and Snyder, 1997), generally do not report high SPA.

Adolescence is considered a socially anxious period of life of many girls. It is accompanied by intense preoccupation with physical appearance that is influenced by sociocultural pressures to attain the thin ideal body (Attie and Brooks-Gunn, 1989; Brooks-Gunn et al., 1989; Hamilton et al., 1985). For adolescents, an increase in body fat may be interpreted as a bodily "flaw" and social liability that may result in potential humiliation and rejection. Adolescent athletes may be particularly prone to SPA because of the changes associated with puberty. For those participating in sports such as gymnastics and figure skating, subjective evaluation may contribute to the manifestation of SPA during adolescence.

Few investigations have considered the relationship between SPA and constructs related to self-concept among adolescent athletes, and no studies have apparently considered SPA relative to the timing of menarche. However, female adolescent female gymnasts (14.4 ± 1.8 years), who are low in self-presentation confidence and physical selfefficacy, report SPA (McAuley and Burman, 1993). In a recent investigation of high performance adolescent female athletes (16.4 $\pm$ 2.4 years) in basketball, tennis, volleyball, gymnastics, diving, synchronized swimming, speed swimming, soccer and softball, SPA was lower than the norms for adult females, and negatively related to two PSDQ constructs, Self-Esteem ($r = -0.74$) and Physical Self-Concept ($r = -0.56$). About 52% of the variance in SPA was accounted for by three PDSQ subscales: Body Fat, Coordination, and Sport Competence (Crocker and Snyder, 1997). Although this study did not report variation by sport, it is interesting that the correlation valences between SPA and each of the 11 PSDQ subscales were negative.

SPA research on young adult women exercisers (18-23 years) suggests that highly anxious women tend to avoid situations where desired impressions are unlikely, and that they use protective strategies such as assuming shielding or unobtrusive postures and wearing oversized clothing (Eklund and Crawford, 1994). Although skaters do not wear oversized clothing during competition, such protective strategies during practice would restrict the ability to execute jumps and spins, and to skate in close proximity to their partners.

Food restriction may be another such strategy. Reel and Gill (1996) investigated psychosocial predictors of eating problems in high school and college cheerleaders 14-23 years of age. Revealing uniforms, periodic weigh-ins, the coach, and stunt partners were among the pressures reported b the cheerleaders. High school cheerleaders exhibited greater body dissatisfaction and disordered eating patterns compared to college cheerleaders. Developmental differences were suggested to account for the differences, but were not assessed. Female high school students may be more predisposed to SPA because of rapid changes associated with the growth spurt and sexual maturation, body dissatisfaction, and/or low self-esteem. However, this study did not include any physical variables related to growth and maturation.

Research examining the contribution of objective physical measures to variability in SPA is equivocal. Eklund and Crawford (1994) and Hart et al. (1989) found that SPA and estimated body composition were positively related in non-athlete adult women. However, body composition and SPA were unrelated in young (13.3 $\pm$ 2.2 years) elite female athletes in soccer players, gymnasts, and figure skaters (Martin et al., 1997). The authors argued that high level of fitness and successful sport experiences may have influenced the favorable self-referent cognitions in the athletes. Martin et al. (1997) assumed later maturation among gymnasts and figure skaters based on previous research (mean ages 15.3 and 15.2, respectively, Wells and Plowman, 1988), and suggested that sociocultural influences would not affect these athletes who were estimated as being in 'early puberty'. Later maturation was suggested to preclude the role of troublesome identity issues associated with changing body image during puberty. Although variation in maturity status may help to explain variability in SPA, an alternative for assessing the relative contribution of objective physical characteristics would be to actually assess physique since it is the basis of the SPA construct. To date, the relationship between SPA and quantitative estimates of physique and maturational status or timing has not been systematically examined.

SPA research also suggests that individuals with high SPA may be particularly at risk for eating problems. SPA is strongly related to bulimic symptomology and moderately related to anorexic symptomology in adult athletes (Johnson et al., 1995). In addition, SPA appears to be a better predictor of eating disorders than other psychological and physical correlates. SPA was the most strongly related predictor of drive for thinness and bulimic symptomology among female college students (Deihl et al., 1998).

Risk of Eating Disorders Among Athletes

Athletes frequently strive to lose weight and some go beyond what is considered healthy. Rosen at al. (1986) reported that 32% of 182 female collegiate athletes from 9 sports (basketball, field hockey, golf, gymnastics, softball, swimming, tennis, track and field, and volleyball) practiced at least one weight-control behavior (e.g., self-induced vomiting, use of laxatives, diuretics, diet pills). Among college gymnasts, 74% engaged in at least one of these behaviors, which was verified in a subsequent study in which 75% of gymnasts reported weight-control behaviors (Rosen and Hough, 1988). Such behaviors can result in under-nutrition, specific nutritional deficiencies, dehydration, loss of electrolytes, hypoglycemia, and excessive adrengeric stimulation. These problems can eventually contribute to decreased performance, an increased risk of injury, and even death (Rosen and Hough, 1988).

There is a general consensus among counseling psychologists that there is link between psychological distress and weight preoccupation among college women. The development of eating disorders in this population stems from achieving autonomy from parents and using self-restraint to establish an internal sense of freedom during adolescence and young adulthood. Self-restraint expressed in terms of weight control and exercise may become destructive, and self-esteem may become solely based on extreme self-denial. In contrast, many "normal" adolescents distinguish themselves from parents and peers through athletics or dance where training requires self-restraint and strenuous exertion. Vigorous self-discipline accompanying the pursuit of excellence in athletics or dance is occasionally mis-identified as psychopathology (Mogul, 1980; Skowron and Friedlander, 1994).

Diagnosing eating disorders requires in-depth clinical assessment by a medical professional. One or two instruments are commonly used to screen for eating disorders: the Eating Attitude Test (EAT: Garner and Garfinkel, 1979, Garner et al., 1982), or the Eating Disorder Inventory (EDI: Garner et al., 1983). Although these instruments were not designed for screening purposes, they provide valuable information about psychological characteristics that typically precede the onset of these eating disorders. The EAT and the EDI are most often employed in empirical investigations for assessing behavioral and psychological characteristics in various population, including adolescents, (Brooks-Gunn et al., 1988; Graber et al., 1994; Mallick et al., 1987; Rosen et al., 1988), weight restricters (Garner et al., 1983; O'Mahoney and Hollwey, 1995; Rosen et al., 1988), and athletes (Klock and DeSouza, 1995; O'Connor et al., 1995; Pasman and Thompson, 1988; Skowron and Friedlander, 1994; Stoutjesdyk and Jevne, 1993; Sundgot-Borgen, 1994; Taube and Blinde, 1992; Taylor and Ste. Marie, 1998; Warren et al., 1990).

The original EAT was a 40-item forced choice Likert scale. Subsequent investigations established three subscales - dieting, bulimia, and oral control (Garner et al., 1983; Williams et al., 1986). A shortened, 26-item version was also developed (Garner et al., 1982). The EAT has been used as a screening device to determine whether individuals whose profession focuses attention on slim body shape are at risk for developing anorexia nervosa. Control subjects had significantly lower mean EAT scores than ballet and fashion model students, and 7% of the latter two groups were subsequently diagnosed by clinical interview as having anorexia nervosa (O'Mahoney and Hollwey, 1995).

The EDI is a 64 item 6-point Likert scale comprised of 8 subscales (a) Drive for Thinness, (b) Body Dissatisfaction, (c) Bulimia, (d) Ineffectiveness, (e) Perfectionism, (f) Interpersonal Distrust, (g) Introceptive Awareness, and (h) Maturity Fears. The EDI subscales provide more robust information about self-perceptions than the EAT. A summary of EDI scores for several populations is presented in Table 6. Female gymnasts and swimmers, and non-athlete female adolescents meet the cutoff criteria for eating disorder risk on the Body Dissatisfaction subscale, but not on the Drive for Thinness subscale. In addition, female athletes in sports emphasizing leanness (divers, cross-country runners, and gymnasts) report higher means for Drive for Thinness than athletes in other sports (golf, rifle shooting, track and field, field hockey).

Despite a widespread belief that athletes are at risk for developing eating disorders, empirical evidence employing the EDI is equivocal, making the diagnostic accuracy of eating disorders among athletes questionable (Schoemaker et al., 1994; Skowron and Friedlander, 1994; Welch et al., 1988). Some studies have shown no differences between athletes and control groups, e.g., clinically diagnosed anorexic patients, and college students (Klock and DeSouza, 1995; Mallick et al., 1987; Pasman and Thompson, 1988; Taub and Blinde, 1992; Warren et al., 1990), while others have found that female athletes in sports such as gymnastics, track, rowing and skating are at risk for developing eating disorders (Davis, 1994; Sykora et al., 1993; Taylor and Ste. Marie, 1998). It has been suggested that these inconsistencies are a function of the transformation of scores from a 6-point scale to a 4-point scale (Schoemaker et al., 1994; Welch et al., 1988). This restriction of range, or lower score variability, decreases the validity of the EDI with non-clinical populations.

Failure to consider maturity status, particularly among adolescent athletes, is another possible factor for inconsistencies in EDI results. Evidence shows that some girls begin to worry about their weight as early as 9 years of age (Brooks-Gunn, 1989; Brooks-Gunn et al., 1985; Koff and Rierdan, 1991; Mallick et al., 1987), suggesting that the transition into puberty may be a risk factor for developing eating disorders. Early maturing girls experiencing increases in body fat have a higher risk of developing eating disorders than later maturers (Attie and Brooks-Gunn, 1989; Graber et al., 1994).

"Because puberty is associated with an increase in adiposity in a culture that values thinness, girls who mature early may be particularly susceptible to unhealthy weight-control behaviors" (Killen et al., 1992, p. 323). As puberty progresses in females, dissatisfaction with their bodies and the desire to be thinner increases (Rosenblum and Lewis, 1999; Brooks-Gunn et al., 1989; Gross and Duke, 1983). Early onset of puberty may be particularly problematic because it is associated with larger body compared to average and later maturing youth at this time. The physical changes, actual or perceived, that accompany adolescence are incorporated into an individual's evolving body image. Body image is a subjective perception of body changes which are personally evaluated in social settings, and this evaluation is involved in psychological adjustment (Kolb, 1959). Early maturation is correlated with negative perceptions of physical characteristics and high prevalence of negative body image (Duncan, 1985; Johnson et al., 1995, van der Velde, 1985), and negative body image is predictive of eating disorders in early- and mid-adolescence (Brooks-Gunn, et al., 1989; Graber et al., 1994). Eating disorders may develop, in part, in an attempt to suppress normal weight gain associated with pubertal growth. Therefore, considering maturational timing may assist investigators interested in identifying groups at risk for developing eating disorders.

EAT and EDI research typically consider age as an important variable in the development of eating disorders, but rarely considers maturational timing which may be a confounding variable. Rosen et al. (1988) provided norms for 747 adolescent females 14-18 years. Girls have significantly more negative eating attitudes than boys on all but three scales of the EDI - Perfectionism, Interpersonal Distrust, and Maturity Fears. Since changes in body form associated with maturation and variation in timing may affect self-perceptions of adolescent females, this investigations should have considered maturity status in developing EAT and EDI norms.

Another possible explanation for the lack of consistency of eating disorder risk among athletes is the practice of grouping athletes together, rather than by specific sports or events within a sport (Hausenblaus and Carron, 1998). Stoutjesdyk and Jevne (1993) examined whether college athletes in sports which emphasize leanness (gymnastics, diving, lightweight rowing, and judo) display a higher tendency towards eating disorders than athletes in other sports (volleyball and heavyweight rowing). Female athletes in sports emphasizing leanness reported higher EAT scores than the non-weight restricted sports. However, no significant differences were found among males in a similar comparison by sport. Overall, 10.6% of the female athletes and 4.6% of the male athletes scored > 30 in the EAT, placing them in the anorexic range.

Sundgot-Borgen (1994) examined risk factors and triggers for eating disorders in 603 elite Norwegian, elite, female athletes, 12 - 35 years of age. Sports were classified as follows: technical sports (alpine skiing, sailing), endurance sports (speed skating, long distance running), aesthetic sports (figure skating, diving), weight dependent sports (karate, wrestling), ball games (handball, table tennis), and power sports (shot put, sprinting). Athletes involved in aesthetic sports (40%) and weight dependent sports (37%) were high in the EDI eating disorder criteria. Subsequently, 103 subjects of the total sample (n = 603) were interviewed and 92 met the clinical criteria for anorexia nervosa and bulimia nervosa.

Other investigations have also highlighted a higher prevalence of eating disorders in sports which emphasize leanness or a specific weight (Brooks-Gunn et al., 1988; Petrie, 1996). Research has focused on divers, cross country runners, rowers, dancers, gymnasts, and figure skaters. Brooks-Gunn et al. (1988) surveyed competitive adolescent female figure skaters, ballet dancers, and swimmers 14 to 18 years of age. Dancers and skaters had more negative eating attitude scores than swimmers, and dancers exhibited more restrained eating than skaters. The authors suggested that low weights may be difficult to maintain for dancers given the fairly low energy demands required for dance. However, the energy demands required for dance were not assessed and may be higher than assumed by the authors. In a survey of 215 female collegiate gymnasts (Petrie, 1993), over 60% of the participants met the criteria for disordered eating and only 22% reported eating behaviors that could be classified as normal or non-disordered. Higher levels of disordered eating disturbance were associated with a desire to weigh less, lower self-esteem, and greater endorsement of sociocultural values regarding women's attractiveness (Petrie, 1993).

In a comparison of figure skaters, ballet dancers and swimmers, the dancers and skaters had more negative eating attitude scores, were lighter and leaner, and were more likely to have later menarche than the swimmers (Brooks-Gunn et al., 1988). The results were consistent with previous research comparing adolescent ballet dancers to non-dancers (Brooks-Gunn, and Warren, 1985). Age at menarche was used to classify the subjects as early ($\leq$ 11.8 years), average or "on time" (11.8-14.2 years), and late ($\geq$ 14.2 years) maturers. These categories were based on a population mean of 12.8 $\pm$ 1.5. More dancers than non-dancers were late maturers. Dancers weighed less and were leaner, had higher eating disorder scores, impulse control scores and reported more negative family relationship experiences than the non-dancers. Across groups, late maturers weighed less, were leaner, and had lower diet and higher oral control scores than "on time" maturers. The differences were more pronounced in the dancers than non-dancers. "On time" dancers had higher psychopathology, perfectionism, and bulimia scores, and lower body image scores than late maturing dancers.

More recently, research has focused on determining the prevalence of eating disorders among figure skaters. Ziegler et al. (1998) reported EAT scores > 30 in only 2 of 21(10%) skaters 11-16 years of age. However, higher EAT scores were associated with lower micronutrient, but not with lower energy intakes. Taylor and Ste. Marie (1998) surveyed 41 pair skaters and dancers 18 to 23 years of age. Three EDI subscales were within the range of eating disorder classification. In this sample, 43% reported high values for Drive for Thinness, 75.6% reported high values for Maturity Fears, and 65.9% reported high values for Perfectionism. Pressures associated with these disciplines, such as weight concerns from male partners and lack of dietary knowledge, were identified as potential contributors to the prevalence of high EDI subscale scores. The identification of specific skating disciplines as being at risk for developing eating disorders is a positive attribute of this investigation. Leanness was emphasized more in pair and dance disciplines than in free skating because of the lifts and/or throws involved in routines. Matching physique characteristics between male and female partners is fundamental in creating aesthetic body lines and in selecting couples for these disciplines. Taylor and Ste. Marie (1998) did not examine differences between pair skaters and dancers.

Brownell (1992) listed several reasons why athletes are particularly at risk for developing eating disorders: (a) performance pressure, (b) coach-athlete relationship, (c) value incongruence, (d) time demands and social isolation, (e) fatigue-related stress, (f) academic pressure, and (g) stereotyping and discrimination by race and gender. Prolonged periods of dieting (37%), hiring a new coach (30%), injury (23%), casual comments form sport officials and peers (19%), and leaving home (10%) were the top five reasons for developing eating disorders indicated by elite eating disordered Swedish athletes (Sundgot-Borgen, 1994). Such sources of stress can be especially taxing on adolescent athletes who are experiencing physical and social changes.

Psychological Skills: Coping

A major tenet in sport psychology is that coping skills are essential for successful sport performance. Coping skills are among the characteristics thought to be important for predicting performance in baseball (Smith and Christiansen, 1995), skiing (Rotella et al., 1980), and water skiing (Black et al., 1997). Coping is defined as “constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands appraised as taxing or exceeding the resources of the person “(Lazarus and Folkman, 1984, p. 141). Coping is not a stable style or trait, and therefore, action can be taken to alter coping strategies.

Coping research in sport psychology is grounded in the conceptual framework of Lazarus and Folkman (1984), which posits that stress relationships occur as a result of a transaction between the environment and personal factors. In this transactional model, cognitive appraisals are involved in determining the meaning of an event. There are three primary stressful appraisals: harm/loss, challenge, and threat. Harm/loss refers to physical or psychological harm already done, such as an injury or loss of self-confidence. Threat refers to the potential of harm or loss. In contrast, challenge refers to a potential for benefit or the opportunity for growth or mastery. Three stressful appraisals transpire when the perceived internal or external demands exceed, or strain, the individual's perceived resources. In this sense, Lazarus and Folkman's (1984) transactional model is analogous to Lerner's (1985) goodness of fit hypothesis.

The transactional model highlights the complex process between environmental demands, perceptions of the demands, and the ability to handle or manage the demands. However, the sources of stress reactions are not solely based on the characteristics of the environment. Coping is a process and should not be confused with outcome. "The athlete may be attempting to cope with a demanding situation, but the selected coping strategies may be ineffective, inefficient, or inappropriate for that specific situation" (Crocker, 1992, p.163). For example, an athlete whose weight is criticized by her coach, may engage in poor eating behaviors as a means of dealing with the criticism.

Coping strategies can be categorized into two functional forms: problem-focused and emotion-focused coping (Lazarus, 1991; Lazarus and Folkman, 1984). Problem-focused coping refers to cognitive and behavioral efforts used to change the problem causing the distress. These strategies include problem solving, planning, information seeking, learning, new skills, and increasing effort. Emotion-focused coping, on the other hand, involves strategies used to regulate emotional arousal and distress. Strategies include mental and behavioral withdrawal, denial, relaxation, and venting of emotions (Crocker, 1992).

The relationship between coping and performance is often assessed through the use of self-report measures comparing specific coping skills of athletes who differ in competitive level. Several studies have shown that elite and better performing athletes have superior coping skills (Mahoney, 1989; Rotella et al., 1980; Smith and Christensen, 1995). Athletes use both cognitive and behavioral strategies for coping with sport-related stresses. Specific strategies have been identified by Lazarus and Folkman (1985) in their 66-item Ways of Coping Checklist (WCC). Participants must think of a stressful situation recently experienced and complete the items on the WCC based upon this situation.

Madden et al. (1990) derived a shorter version (54 items) of the WCC for college basketball players, the Ways of Coping with Sport Checklist (WCSC). Like the original instrument, the WCSC has eight subscales: (a) general problem-focused, (b) seeking social support, (c) emotionality, (d) increased effort and resolve, (e) detachment, (f) denial, (g) wishful thinking, and (h) focusing on the positive. In the construction of the WCSC, the basketball players completed a questionnaire regarding their most stressful experience in the sport. The most frequently cited response was used to standardize a situation to which the players responded. Limited information regarding the psychometric properties of the WCSC was provided by Madden et al. (1990).

More recently, Crocker (1992) modified the original WCC and examined its psychometric properties through exploratory factor analysis. In this version athletes (basketball, volleyball, soccer, hockey, ski jumping, cross country, swimming, field hockey, wrestling, gymnastics, track and field, and cycling) competing at league regional, provincial, national, or international levels described in a written format their most stressful experience in their respective sport within the previous three weeks. Subsequently, they responded to the WCC based on their descriptions. Although the two sport versions of the WCC have yet to undergo extensive psychometric testing, the consensus is that more successful athletes use more positive methods of coping such as seeking social support, increasing effort and resolve, and focusing on the positive, than less successful athletes.

Summary

Gaining a performance advantage in a specific sport depends upon the numbers and characteristics of athletes involved in the sport. Probability suggests that a certain number of athletes will rise to the top and a variety of physical and psychological characteristics may identify elite athletes. Isolating such characteristics may be beneficial for talent identification and safe participation in a given sport. One method of identifying predictive variables is to examine the characteristics of elite athletes and then search for gifted, young athletes using these characteristics as a standard of comparison (Comper, 1991). Alternatively, cross-sectional comparisons of elite and non-elite participants can identify both positive and negative characteristics associated with a sport. However, little, if anything, is reported about the characteristics of individuals who are identified as talented but who do not make it through the selection process (Malina, 1997).

Physique is an important variable in figure skating where shortness and leanness are the norm for the elite female skater. Coping with the stresses involved in skating, including maintaining a low body weight, requires appropriate strategies. Skaters engaging in inappropriate strategies may have a tendency to experience anxiety that can interfere with performance, perhaps leading to attrition. The type of anxiety experienced by skaters may be a function of the subjective evaluation inherent in figure skating and of physical characteristics associated with variation in rate of maturation. Specifically, self-presentational anxiety such as SPA, together with inappropriate coping skills, may result in poor Physical Self-Concept, affecting overall self-concept. Consistent with Lerner's (1992) goodness-of fit hypothesis, a mismatch between an individual's characteristics and those required for the sport of figure skating may lead to problem behaviors. Figure skaters striving to maintain the ideal physique may also be at risk for developing eating disorders.

CHAPTER III

Methodology

Subjects

Subjects were 161 female figure skaters participating at four United States Figure Skating Association (USFSA) clubs (n = 37), and seven Canadian Figure Skating Association (CFSA) clubs (n = 124). Three additional skating clubs (1 U.S. and 2 Canadian) declined requests for participation (Appendix A) and two Canadian clubs selected the skaters who could participate. One of these clubs was a leading pair skating training facility and did not permit the investigator to have access to testing pair skaters. The ethnic composition of the sample was 94% Caucasian (n = 150), 5% Asian (n = 9), and 1% Black (n = 2), and the age range was 11.5 to 22.3 years. Purposive sampling was used to recruit skaters across three levels of competency (test-stream, pre-elite and elite) and three disciplines (free skating, dance and pair skating). Test-stream participants are skaters participating in advanced recreational programs, but who do not compete at the national or sub-national level. Pre-elite participants are USFSA or CFSA novice competitors who have competed in at least one previous national qualifying competition (e.g., sectionals, divisional). Elite participants are USFSA or CFSA junior and senior participants who have competed in at least one prior national qualifying competition.

Two outliers, one Caucasian test skater who was obese (BMI = 30.6 kg/m^2), and one Asian pre-elite free skater who was $\geq$ 3 standard deviations below the age-specific reference for height, were deleted from the sample. The distribution of the remaining 159 subjects by age, ethnicity, level and discipline is summarized in Table 7. There are more pre-elite skaters (42%) than test level (29%) and elite skaters (29%) [$\chi^2(4) = 38.0$, $p \leq .001$] and more free skaters (68%) than dancers (18%) and pairs skaters (14%) [$\chi^2(4) = 37.7$, $p \leq .001$].

Measures and Instrumentation

Demographic Background

The following background information was collected: date of birth, age of first organized youth sport experience (skating or other), age at figure skating specialization, reason(s) for specializing in figure skating, significant others who influenced figure skating participation, skating club membership(s), training location, current competitive level, skating discipline, competition history, number of competitions in the current competitive year, number of competitions in the previous competitive year, and number of hours of training per week. Parental background information included reported stature and weight, education, occupation, current sport participation, age when first child was born, mother's age at menarche, number of children in the family, and birth order of skater. The demographic forms are presented in Appendix B.

Anthropometry

The protocol for anthropometric data collection and reliabilities were established during a pilot testing session. Here, three volunteers were measured by two investigators. Measurement reliability (Technical Error of Measurement [TEM], Malina, 1995) between the same two technicians was also calculated with additional volunteers after completion of the study. All reliability observations are within-day replicates with one hour between replicates. The primary technician collected the majority of the data with the exception of data collected on 10 participants (excluding skinfolds) at the first site. The technicians were both trained in anthropometry and in interviewing for age at menarche. Intra-rater reliability was calculated for the primary investigator. At least one participant from each testing site was measured twice by the primary investigator.

Anthropometry was done during the Winter/Spring skating season of 1998 to ensure that all skaters had been training. Skaters were measured in a private room free from distraction. Anthropometric data were collected first, followed by a short interview regarding age at menarche (Appendix C). The primary investigator asked each skater if she had attained menarche, and if so, to recall when. This was done in private and the skaters were assured, again, that all of their answers were confidential.

The following anthropometric dimensions were taken using the anthropometric procedures described in Lohman et al. (1988): body weight, stature, sitting height, skinfolds, skeletal breadths, and limb circumferences. Several of the dimensions were used to estimate somatotype (physique) using the Heath-Carter anthropometric protocol (Carter and Heath, 1990).

Weight was measured using a Metro scale with both kilograms and pounds displayed as units of measure. Stature, sitting height, and skeletal breadths were measured with a GPM field anthropometer. A small sliding GPM caliper was used to measure biepicondylar breadth. Three measures of each skinfold were taken to the nearest 0.1 mm on the right side of the body using a Holtain caliper. The average of the readings was used. Girth measurements were taken on the right side of the body with a fiberglass tape. **Weight (kg)** was measured to the nearest 0.1 kg with the subject barefoot and in T-shirt and shorts.

Stature (cm) was measured to the nearest mm with the subject standing on the floor without shoes, heels together and weight evenly distributed. The measurement was taken from the rear with the subject's head in the Frankfort horizontal plane.

Sitting height (cm) was measured with the subject seated on a table with legs hanging freely. The subject was positioned erect with the head in the Frankfort horizontal plane. The measurement was the distance from the top of the table to the vertex of the head.

Circumferences were measured to the nearest mm on the right side of the body at the following sites:

Upper arm (relaxed), at the marked level midway between the acromial and olecranon processes with the arm hanging freely at the side.

Upper arm (flexed), at the maximum circumference of the arm with the subject maximally flexing the biceps with the elbow at 90° angle.

Thigh, immediately below the gluteal fold with the subject standing, feet shoulder width apart, and body weight evenly distributed on both feet.

Calf as the maximum measurement with the subject standing with the body weight equally distributed over both feet.

Skeletal Breadths were measured to the nearest mm at the following sites:

Biepicondylar, as the distance between the epicondyles of the right humerus with the subject flexing the elbow 90°.

Bicondylar, as the distance between the condyles of the right femur. The subject was seated on a chair with the knee flexed at a 90° .

Skinfolds were taken on the right side of the body to the nearest 0.1 mm at the following sites:

Biceps, at the midpoint of the right upper arm over the belly of the biceps muscle with the arm relaxed at the side.

Triceps, a vertical fold in the midline of the posterior aspect of the arm over the triceps muscle at the same level as relaxed arm circumference.

Subscapular, 1 cm below the inferior angle of the scapula, following the natural cleavage of line of the skin.

Supraspinale, 5 cm superior to the anterior spine of the iliac crest along a 45° angle to the horizontal in the natural cleavage line of the skin.

Abdominal, a horizontal skinfold at a site about 3 cm lateral to the midpoint of the umbilicus and 1 cm below it.

Medial calf, a vertical fold at the level of the maximum calf circumference on the medial aspect of the calf with the foot placed on a platform to create on 90° angle at the knee.

Measurement Reliability and Variability

Within day replicates of anthropometry were done on 13 subjects by the primary investigator to estimate intra-observer measurement variability. Fifteen subjects were measured by the primary investigator and an assistant to estimate inter-observed measurement variability. Intra-observer variability for anthropometry was calculated from the absolute differences between the first and second measurements of the same subject. The technical error of measurement (TEM, Malina, 1995) was used as the indicator of measurement variability:

$$\text{TEM} = \sqrt{(\Sigma d^2)/2n}$$

where TEM the square root of the sum of the squared differences of replicate measurements ($\Sigma d2$) divided by twice the number of pairs (2n).

Intra- and inter-observer technical errors of measurements are presented in Table 8. Inter-observer technical errors for skinfolds are generally larger than in other studies summarized in Table 8. However, intra-observer technical errors for skinfolds are comparable to those of other studies. Inter- and intra-observer errors for other anthropometric dimensions are, with few exceptions, comparable (Table 8) and are within acceptable ranges for field studies (Malina 1995).

Derived Measurements and Indies

<u>Body Mass Index (BMI)</u> was calculated as weight (kg)/stature^2 (m).

<u>Estimated leg (subischial) length (cm)</u> was calculated as stature minus sitting height.

<u>Sitting Height/Stature Ratio</u> was calculated as sitting height (cm)/height (cm) x 100.

<u>Estimated mid-arm muscle circumference</u> (EAMC, Malina, 1995):

$$EAMC - Ca - (\Pi/2) * (\text{triceps} + \text{biceps skinfolds})$$

where Ca = relaxed arm circumference

<u>Estimated calf muscle circumference</u> (ECMC, Malina, 1995)

$$ECMC = Ca - (\Pi/2) * (\text{medial calf skinfold})$$

where Ca = calf circumference

<u>Heath-Carter anthropometric somatotype</u> was computed as follows:

$$\text{Endomorphy} = -0.7182 + 0.1451 (X) - 0.00068 (X^2) = 0.000014 (X^3)$$

where X = (triceps + subscapular + supraspinale skinfolds) * (170.18/stature cm)

Mesomorphy = ((0.858 biepicondylar + 0.601 bicondylar + 0.188 corrected arm circumference + 0.161 corrected calf circumference) - (height * 0.131)) + 4.50, where corrected arm = arm circumference flexed (cm) - triceps skinfold (cm), and corrected calf = calf circumference (cm) - medial calf skinfold (cm).

Ectomorphy = HWR * 0.732 - 28.58 where HWR = height (cm)/ weight (kg) 1/3 or height divided by the cube root of weight. If HWR $\leq$ 40.75 $\geq$ 38.25, ectomorphy = HWR * 0.463 - 17.63; if HWR $\leq$ 38.25, Ectomorphy = 0.01 (Carter and Heath, 1990).

Maturation

Menarcheal Status

Each skater was asked whether or not she attained menarche (yes/no). Post-menarcheal females were interviewed as to when menarche occurred. They were asked to recall the age at menarche to the nearest month (Appendix C). "Time of year", "season" and specific competitions were used as prompts to ascertain specific answers. Probit analysis was used with the status quo data to estimate the median age at menarche and 95% confidence intervals for the sample. Mothers were also asked to recall their age at menarche. Unfortunately, mothers reported their ages only as whole years. Thus, 0.5 was added to each age (Livson and McNeil, 1962).

Psychological Variables

<u>Coping</u>

Ways of Coping Checklist (WCC, Crocker, 1992)

The WCC is a 68-item questionnaire comprised of eight subscales: Active Coping, Problem Focused Coping, Social Support, Reappraisal, Wishful Thinking, Self-Control, Detachment, and Self-Blame (Appendix D). Each item is rated on a 4-point Likert scale where 1 = not used, 2 = used somewhat, 3 = used much, and 4 = used a great deal. Alpha coefficients above 0.70 have been reported for participants 12 years of age and older (Crocker and Snyder, 1997). Cronbach (1951) alpha coefficients for the present sample (n = 138) range from 0.09 to 0.76. Participants were requested to think of their most stressful skating experience and complete each WCC item based on this situation. Since only three subscales had acceptable reliabilities, the WCC was excluded from subsequent analyses (Table 9).

<u>Self-concept</u>

Physical Self-Description Questionnaire (PSDQ, Marsh, 1996).

The PSDQ is a 70-item self-report test measuring nine components of Physical Self-Concept: Appearance, Coordination, Endurance, Flexibility, Strength, Health, Physical Activity, Body Fat, Sport, and two global components: Global Physical Self-Concept and Self-Esteem. Each item is a declarative statement and participants respond on a 6-point true-false response scale (Appendix D). The PSDQ shows no sex differences. It has been used with youth 12 to18 years of age, and has been recommended as appropriate for older subjects (Marsh et al., 1994). Cronbach (1951) alpha coefficients for the 11 subscales in the present sample (n = 128) range between 0.81 and 0.94 (Table 9). The criteria for external validity include estimates of body composition (BMI, girth and skinfold measurements), silhouette ratings, physical activity participation and adherence, physical activity levels, endurance(12-Minute Run), explosive/dynamic strength (vertical jump), static strength (hand grip dynamometer), and flexibility (sit and reach). Each of these variables was correlated (0.25 to 0.64) with at least one of the PSDQ subscales (Marsh, 1996).

Eating Disorder Risk

Eating Disorder Inventory (EDI, Garner et al., 1983)

The EDI consists of cognitive and behavioral dimensions to help differentiate individuals with severe psychopathology from extreme dieting. The 64-item self- report inventory consists of eight subscales: Drive for Thinness, Bulimia, Body Dissatisfaction, Ineffectiveness, Perfectionism, Interpersonal Distrust, Introceptive Awareness, and Maturity Fears (Appendix D). The subscales were derived from a large pool of items generated by clinicians involved with the research and treatment of patients with anorexia nervosa. To be included in a subscale, an item had to be answered significantly differently by control patients compared to those with anorexia nervosa.

Scores range from lowest to highest where 1 = 'never', 2 = 'rarely', 3 = 'sometimes', 4 = 'often', 5 = 'usually', and 6 = 'always'. Scoring the EDI involves summing the responses after condensing the 6-point Likert scale to a 4-point scale where a scores of 1 through 3 are recoded as 0, 4 is recoded as 1, 5 is recoded as 2, and 6 is recoded as 3. Individuals scoring $\geq$15 and $\geq$10 on the Drive for Thinness and Body Dissatisfaction scales, respectively, are considered at risk for developing eating disorders

(Garner and Olmstead, 1984). Alpha coefficients for samples 14 to18 years are 0.78 and higher (Rosen et al., 1988). For the present sample (n = 126), Cronbach (1951) alpha coefficients range from 0.70 to 0.94 (Table 9).

<u>Social Physique Anxiety</u>

Social Physique Anxiety Scale (SPAS, Hart et al., 1989)

The SPAS is a 12-item self-report questionnaire. Each item is scored on a 5-point scale where 1 = 'not at all', 2 = 'slightly', 3 = 'moderately', 4 = 'very' (4), 5 = 'extremely'. Items 1,5,8, and 11 are reverse scored (Appendix D). Alpha coefficients range from 0.77 to 0.92 for males and 0.74 to 0.93 for females 13 years of age and older (Crocker and Snyder, 1998; Petrie et al., 1996). The Cronbach (1951) alpha coefficient for the present sample (n = 135) is 0.91 (Table 9) and there is a positive correlation between SPA and chronological age ($r = 0.30$, $p \leq 0.001$).

Procedures

Upon obtaining the University Committee for Research Involving Human Subjects (UCRIHS) from Michigan State University (Appendix E), initial consent for conducting the research was requested by the primary investigator from the figure skating clubs. Officials from 13 figure skating clubs in southern Ontario and mid-Michigan were contacted by phone or in person. The study was described and questions regarding the study were answered at this time. Eleven club officials agreed to participate, providing a meeting time and a room for a general meeting. Participation and consent was solicited from parents and athletes at the information meeting, or personally by the primary investigator. Participants and their legal guardians formally indicated consent by signing a consent form (Appendix A).

At the initial meeting, skaters expressing interest in participating in the study were given a questionnaire package. In addition, a time for anthropometry was tentatively set. Skaters were instructed to complete the questionnaire and return it to the primary investigator at the time the measurements were taken. Anthropometric dimensions were take within one month of the initial request for participation.

The number of participants varies across analyses because of incomplete data (Table 10). Participation in anthropometry and completing the questionnaire package required a substantial amount of time. Some skaters took the questionnaires home and did not return them to the investigator. Other skaters mailed the questionnaire package to the primary investigator, whereas others submitted their questionnaires in sealed envelopes to skating club officials, who sent them to the primary investigator. Anthropometric data were collected before, during, after, or in between practices which made it difficult for some skaters to complete the questionnaires by the time anthropometric dimensions were taken. Many parents did not complete the questionnaire, perhaps because some of the skaters lived away from home to train and did not see their parents regularly. Many of the mothers omitted questions about weight and menarche perhaps because of the personal nature of the questions and/or unfamiliarity with the term menarche.

Analyses

Question 1

What are the anthropometric, physique, menarcheal, and psychological characteristics of female competitive figure skaters ages 11 years and older?

Means and standard deviations for each measured or derived variable were calculated. Medians were calculated for fat-related variables. Where available, anthropometric data were plotted relative to U.S. reference values. Probit analysis was used with the status quo data to estimate the median age at menarche of the sample. Due to the broad age range of the sample, correlations were calculated between chronological age and all dependent variables. Low ($\leq$ 0.39), moderate (0.40 - 0.69) and high correlations ($\geq$ 0.70) are based on the magnitudes defined by Cohen (1988). Since most correlations were significant, age was controlled in subsequent analyses.

Questions 2 and 3

Do the physical and psychological characteristics of competitive skaters differ by age across competency levels? Do the physical and psychological characteristics of competitive skaters differ across discipline?

To determine if there were differences among test, pre-elite and elite skaters, several Analyses of Covariance (ANCOVA) with age as the covariate were done for each anthropometric variable, menarche, and SPA by level. Separate MANCOVA were conducted for endomorphy, mesomorphy and ectomorphy with age and the two remaining somatotype indicators as covariates. Post hoc comparisons were made using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 (Cressie et al., 1986). For all other analyses, alpha was set at .05.

Subscales of the PSDQ and EDI were grouped together and a Multiple Analysis of Covariance (MANCOVA) was calculated do determine group differences for each of the psychological instrument subscales by level. Two MANCOVA were also calculated by discipline to determine if there were differences among free skaters, dancers and pair skaters. Chi square analysis was used to examine the proportion of skaters meeting the eating disorder criteria across level and discipline. Chi square analysis was also used for age at menarche to examine the proportion of average and late maturing skaters across level and discipline. Due to the large standard deviations for the EDI subscale scores, medians are provided.

Question 4

Do the physical and psychological characteristics of figure skaters differ relative to menarcheal status and timing?

ANCOVA was used to compare the anthropometric, somatotype, and psychological characteristics of pre- and post-menarcheal skaters, and of average and late maturing post-menarcheal skaters $\geq$ 16 years of age (maturational timing). The Cressie et al. (1986) analytical protocol was used for somatotype. For all other analyses alpha was set at .05

Question 5

Are the physical characteristics of figure skaters correlated with self - perceptions of physical dimensions?

To examine the relationship between physical variables and physical self-perceptions, partial correlations controlling for chronological age were conducted. Selected anthropometric dimensions related to body size, proportions and fatness were correlated with selected psychological variables that were related to perceptions of physical characteristics: PSDQ subscales (Body Fat, Global Physical Self-Concept, Appearance, and Self-Esteem), EDI subscales (Drive for Thinness, Bulimia, Body

Dissatisfaction, and Maturity Fears), and SPA. For somatotype, correlations between each component and the psychological variables were calculated as partial correlations controlling for age and the other two somatotype components. Second-order partial correlations were also calculated for height, weight, and the sum of 6 skinfold thicknesses and each psychological variable controlling for age and one of the physical variables.

Questions 6

Can a selection of physical and psychological characteristics thought to be important for elite and specialized figure skating discriminate level of competency and disciplinary involvement?

Discriminant function analyses were conducted to determine if a combination of physical and psychological characteristic could correctly classify the figure skaters (total sample and skaters $\geq$ 15 years) by level and disciplinary involvement.

Question 7

Can self-perceptions characterized by Social Physique Anxiety, Global Physical Self-Concept, and Self-Esteem be predicted by a unique set of physical and psychological variables?

A multivariate-multiple regression analysis was performed to determine if psychological variables reflecting self-perceptions, which include SPA, Global Physical Self-Concept and Self-Esteem, could be predicted by a combination of physical and psychological variables. SPA, Global Physical Self-Concept and Self-Esteem were chosen because these variables are thought to be important for athletic success (Crocker and Snyder, 1997), particularly for those participating in aesthetic sports. Due to the sample size (n = 114), the set of physical and psychological predictor variables included age, height, weight, somatotype (endomorphy, mesomorphy, ectomorphy), Appearance, Body Fat, Body Dissatisfaction, Drive for Thinness, and Perfectionism.

<u>Question 8</u>

Can the susceptibility to eating disorders identified by Bulimia, Drive for Thinness, Body Dissatisfaction, Perfectionism and Maturity Fears be predicted by anthropometric characteristics, somatotype and psychological variables related to physique, appearance and self-concept?

Stepwise regression analysis, controlling for age, was performed for each of the EDI subscales on the total sample. Five subscales of the EDI were chosen as relevant factors representing risk for eating disorders in adolescent figure skaters. Bulimia was chosen because it is the only behavioral indicator of disturbed eating patterns represented in EDI. Drive for Thinness and Body Dissatisfaction involve physical self-perceptions. The perception of maturity (Maturity Fears) is also of interest because most of the skaters were adolescent and pubertal maturation influences body composition and physique. Since, expectations of perfection are inherent in skating, Perfectionism is also considered. The three remaining constructs (Ineffectiveness, Introceptive Awareness, and Interpersonal Distrust) are concerned with social adjustment and are not relevant to this athletic context; therefore they are excluded from the analysis.

Chapter IV

Results

Demographic characteristics of skaters and their parents are first described, and then each of the research questions outlined in Chapters I and III is addressed. The growth, maturational, and psychological characteristics of the young female skaters are described. Selected growth and maturational variables are presented relative to U.S. reference values. When available, psychological characteristics are compared to normative data. Physical and psychological variables are then compared by competency level and by discipline. Comparisons between pre- and post-menarcheal skaters are examined followed by a comparison of post-menarcheal skaters ≥16 years of age characterized as average and late maturing (two early maturers were excluded). Next, the relationship between physical and psychological variables, and predictors of level and disciplinary participation are examined. The self-concept of the skaters is then considered. Finally, predictors of risk for eating disorder are considered.

Demographic Characteristics

Skaters

Experience in organized figure skating ranges from 3.5 to 17.1 years, and mean years of experience increases with age to about 17 years (Table 11). The first organized sport experiences reported by skaters are variable and include roller skating (1%), running (1%), hockey (1%), skiing (2%), t-ball (3%), soccer (7%), swimming (12.4%), gymnastics

(15.4%), ballet (19%), and skating (40.2%). However, only 11% of the skaters report participating in other organized sports at the same time they train in figure skating.

Descriptive statistics for the background characteristics for total sample of the skaters and correlation with skating level are presented in Table 12. Correlations are low (-0.28 to 0.39) between level and years of experience, age at first competition, number of competitions in 1997, and training hours on and off of the ice. Results of the ANOVA comparing background information for the skaters by level and discipline are presented in Tables 13 and 14, respectively. Age at first competition, years of skating experience, years of disciplinary experience, number of competitions in 1997 and 1998, and hours of training on and off of the ice differ significantly by level. Post hoc analyses using Tukey's HSD indicate that test skaters are older at first competition than both pre-elite and elite skaters. Elite skaters have more years of experience than pre-elite and test skaters, and more disciplinary experience compared to test skaters. Pre-elite and elite skaters participated in more competitions in 1997 compared to test skaters, while pre-elite skaters had more competitions in 1998 than test skaters.

Years of skating experience, years of experience in a particular discipline, number of competitions in 1998, and weekly on-ice training hours differ significantly across discipline. Post hoc analyses indicate that free skaters have less overall skating experience compared to pair skaters, and that dancers have less disciplinary skating experience than either free or pair skaters. Pair skaters participated in more competitions in 1998 than either free skaters or dancers, and spend more time training on-ice than free skaters. Dancers also spend more time training on-ice than free skaters (Table 14).

The proportion of skaters reporting parental influence (i.e., mothers and fathers) on their skating participation is higher than the proportion of skaters reporting influence from a coach, friend, or others (Table 15). Skaters report their mothers as most influential. Other factors influencing skating participation include grandparents, the 1988 Olympic athletes, and self-motivation. The figure skaters tend to be first (54 of 111, 48.6%) or second (44 of 111, 39.6%) born. This reflects family size, 2.2 $\pm$ 0.8 children. Four of the skaters (4%) were adopted so that birth order and family size information were not available. Within 2-child families, the figure skaters are evenly divided between first and second born (Table 16). In larger families, the skaters are distributed across birth order positions. Six percent (n= 7) of the 110 skaters receive funding and 14.5% live away from home to train.

Parents

Most mothers and fathers have college degrees, both undergraduate or graduate, but more fathers than mothers specify graduate degrees (Table 16). In addition, 44% of fathers (n = 98) and 39% of mothers (n = 106) report participating in organized sport at present. Descriptive statistics for reported height and weights, of mothers and fathers, and age at menarche of the mothers are shown in Table 17. There are no differences by level or discipline. But, there is a trend for mean ages at menarche of mothers to increase from test to pre-elite to elite skaters [$F(2) = 0.8$, $p > .05$] and from free skaters to dancers to pair skaters [$F(2) = 1.1$, $p > .05$].

Research Questions and Hypotheses

Question 1

What are the anthropometric, physique, menarcheal, and psychological characteristics of female competitive figure skaters ages 11 years and older?

Anthropometric Characteristics

H1: Figure skaters are smaller in height, weight, limb circumferences and skeletal breadths, and leaner compared to reference data for non-athletes.

Descriptive statistics for all body dimensions for the total sample is presented in Table 18 and corresponding statistics by single year chronological age groups are presented in Appendix F. Age is significantly correlated with most variables; it is thus used as a covariate in subsequent analyses. Data for stature, weight, the BMI, sitting height, estimated leg length, the sitting height/stature ratio, bicondylar and biepicondylar breadths, relaxed arm and calf circumferences, and the subscapular and triceps skinfolds are shown in Figures 2 through 13 relative to U.S. reference values. The 10^{th} (P10), median (P50), and 90^{th} (P90) percentiles are used for height and weight, while the 15^{th} (P15), 50^{th} (P50), and 85^{th} (P85) are used for the BMI. Medians are used for the other variables. Data for individual skaters are shown in the upper part and age-specific means are shown in the lower part of each figure.

Individual statures and weights are distributed between P10 and P90. Two skaters are above P90 for stature and proportionally more are below P10 for stature than for body weight (Figures 2 and 3). Mean statures and weights of figure skaters are generally below the reference medians at most ages (lower part, Figures 2 and 3). The majority of individual values for the BMI are between P15 and P85, but two are at or above P85 and 17 are at or below P15, suggesting low weight for stature, particularly among skaters ≤16 years. Among skaters ≥16 years of age, many have BMIs that are equal to or above the reference medians (Figure 4). Mean BMIs are near or above the reference medians at all ages except 11 years.

Mean sitting heights and estimated leg lengths parallel the trends for stature, i.e., they are generally below the reference medians at most ages (Figures 5 and 6, respectively). Mean sitting height/stature ratios are at or below the reference medians from 11-14 years. Subsequently, mean ratios are at or above the reference means, indicating a trend for proportionately shorter legs among the older skaters (Figure 7). Mean biepicondylar breadths are consistently below the reference medians (Figure 8), and mean bicondylar breadths are at or below the reference medians (Figure 9).

Mean relaxed arm and calf circumferences are both below the reference medians, and the trend is more apparent for arm circumference (Figures 10 and 11, respectively). Median triceps and subscapular skinfolds are consistently below the reference medians (Figures 12 and 13, respectively).

Physique

Somatotypes of the majority of skaters are distributed between the endomorphy-mesomorphy and mesomorphy-ectomorphy axes of the somatochart (Figure 14). Mean Heath-Carter anthropometric somatotypes are presented by age group in Table19 and Figure 15. Endomorphy increases with age to 17 years, mesomorphy is rather stable across age, and ectomorphy decreases with age especially in skaters 16 years and older. Overall, the mean somatotype is balanced.

H2: Figure skaters are later maturing compared to reference data for non-athletes.

In this sample of figure skaters, 111 attained menarche whereas 48 did not attain menarche at the time of survey. The median age at menarche based on probits is 14.2 $\pm$0.5 years, with a 95% confidence interval of 13.2 to 15.2 years. The mean age at menarche based on recalled ages for skaters $\geq$ 16 years is 13.6 $\pm$1.2 years. The median and mean ages at menarche of the skaters are later than the reference value for American White girls, 12.8 $\pm$ 1.0 years (Eveleth and Tanner, 1990), thus supporting the hypothesis. The distributions in Tables 20 also indicate that early maturing girls (menarche $\leq$ 12.0 years) are under represented in the sample of figure skaters; only two skaters attained menarche < 12.0.

Post-menarcheal skaters $\geq$ 16 years with recalled age at menarche between 12.0 and 13.99 are classified as average maturers (n = 46), and those skaters with recalled ages at menarche $\geq$ 14.0 years (n = 19) are classified as late maturers. Two skaters are early maturers (menarche $\leq$ 12.0 years).

The distribution of recalled ages at menarche for all post-menarcheal skaters $\geq$16 years and their mothers is presented in Table 21. Mean ages at menarche of mothers and their figure skating daughters are reasonably similar, allowing for error of the recall in the retrospective method. The correlation between recalled ages at menarche of skaters and their mothers (n = 28 pairs) is 0.60 (p = .001).

H3: Physical self-perceptions decrease with age, while social physique anxiety and eating disorder risk increase with age.

Descriptive statistics for the psychological inventory subscales for the total sample is given in Table 22. Descriptive statistics by chronological age groups are shown in Appendix F (Tables 10 - 12). Supporting hypothesis 3, age is significantly correlated with SPA and most subscales of the PSDQ and EDI. For the PSDQ, these include Body Fat, Physical Activity, Global Physical Self-Concept, Health and Sport Competence. For the EDI subscales, Body Dissatisfaction, Bulimia, Drive for Thinness, Ineffectiveness, Maturity Fears, and Introceptive Awareness are significantly related to age. With the exception of age and Sport Competence, correlations between age and physical self-perceptions are low and negative, ranging from -0.23 to -0.31, while correlations between age and the EDI subscales are low to moderate and positive, ranging from 0.23 to 0.42 and the correlation between age and SPA is 0.33 ($p \leq .05$). In sum, physical self-perceptions decrease with age while eating disorder risk and social physique anxiety increase with age.

None of the 11 and 12 year old skaters meet the Body Dissatisfaction and Drive for Thinness criteria for eating disorder risk classification (scores $\geq$10 and $\geq$ 15, respectively). Risk classification is more common in skaters 15 years and older. The proportion of skaters in each age group meeting the Body Dissatisfaction criteria ranges from 10% (14 and 15 years) to 47% (17 years), while those meeting the Drive for Thinness criteria from range from 5% (13 and 14) to 24% (17 years). Of the total sample (n =126), 29% (n = 37) meet the criteria for Body Dissatisfaction and 12% (n = 15) meet the criteria for Drive for Thinness (Appendix F, Table 11).

H4: Figure skaters will have higher PSDQ scores, and lower SPAS and EDI scores than non-athletes.

Since there are no reference values for a representative sample of North American adolescent girls, the mean values for samples of non-athletes are used for comparison. It is not certain if the non-athletes are representative of the adolescent population of North American girls. The PSDQ scores of figure skaters are higher than a sample of younger female non-athletes with the exception of Health (Table 23). The mean for the total sample is lower than the reference values for young adult college students, but SPAS means for skaters 16 years and older are closer (Table 24). EDI means for the total sample of skaters are lower than the means for adult bulimic anorexics and the norms for adolescent females with the exception of Maturity Fears (Table 25). The means of skaters older than 16 years are higher than the norms for college women for each of the EDI subscales except Body Dissatisfaction and Perfectionism.

Question 2

Do the physical and psychological characteristics of competitive skaters differ across competency levels (test, pre-elite and elite)?

H5: Elite figure skaters have a unique set of physical and psychological characteristics compared to test and pre-elite skaters.

Physical Characteristics

To examine age-related trends in anthropometric characteristics, skaters were classified by level into four age groups: group 1: 11.0-12.9, group 2: 13.0-14.9, group 3:

15.0-16.9, and group 4: 17.0+ years. Descriptive statistics are shown in Table 26. Age-related trends across level indicate that pre-elite and elite skaters are lighter than test skaters until about 14.0 years, but pre-elite and elite skaters are shorter than test skaters after 14 years of age. In general, pre-elite skaters are smaller than both test and elite skaters until about 17 years, whereas test skaters are larger than both pre-elite and elite skaters across the age span studied.

Differences in skeletal breadths are small. Pre-elite skaters generally have smaller limb circumferences than test and elite skaters with little variation between test and elite skaters to 15 years. Older elite skaters are smaller than test skaters after 15 years. The trend for individual skinfold thicknesses is variable, but test skaters tend to have a greater sum of 6 skinfolds than older skaters. Older test skaters also have proportionately more subcutaneous fat on the trunk, i.e., higher T/E ratio (Table 26).

Test skaters tend to be more endomorphic than pre-elite and elite skaters, whereas elite skaters $\geq$15 years are more mesomorphic than test and pre-elite skaters (Table 26). Pre-elite skaters tend to be somewhat more ectomorphic across age groups.

To determine group differences across competitive levels, analysis of covariance (ANCOVA) with age as the covariate was conducted for each anthropometric variable. Descriptive statistics by level are shown in Table 27 and the results of the ANCOVAs and adjusted means are summarized in Table 28. Elite skaters tend to show less variability than test and pre-elite skaters as evident in the smaller standard deviations in many dimensions (Table 27). Only stature, estimated leg length, bicondylar breadth, and biepicondylar breadth do not differ among the skaters by level (Table 28). All other variables differ significantly. Post hoc analysis indicate that test skaters are larger and/or heavier than pre-elite skaters in weight, the BMI, sitting height, and the sitting height/standing height ratio, and taller than elite skaters in sitting height. Test skaters are also larger than pre-elite and elite skaters in limb circumferences and greater than elite skaters for relaxed arm, calf and corrected calf circumferences. Test skaters have thicker skinfolds than both pre-elite and elite skaters. Elite skaters have a larger BMI and a higher sitting height/stature ratio than pre-elite skaters. Although the trunk/extremity ratio does not differ by level, elite skaters tend to have proportionally less subcutaneous fat on the trunk. Comparisons of pre-elite and elite skaters indicate that pre-elite skaters are smaller than elite skaters in the BMI, arm, thigh and corrected arm circumferences and the triceps skinfold thickness. Pre-elite skaters also have a lower sitting height/stature ratio indicating proportionately larger legs.

Mean somatotypes of figure skaters by level are presented in Figure 16. MANCOVAs were conducted for each somatotype component by level with age and the two other somatotype components held constant. Although the individual somatotypes of figure skaters seem to cluster within a relatively narrow range of the somatochart, post hoc comparisons using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 (Cressie et al., 1986) indicate that test skaters are more endomorphic than either pre-elite or elite skaters, and that test and pre-elite skaters are more ectomorphic than elite skaters (Table 28). Overall, the results support the hypothesis that elite and pre-elite skaters can be differentiated from test skaters on the basis of their physical characteristics.

Psychological Characteristics

Mean scores for each psychological inventory subscale by level and age group are presented in Table 29. Among the youngest skaters, pre-elite skaters report higher mean scores than test skaters for all of the PSDQ subscales except Health and Appearance, while pre-elite and elite skaters report higher scores than test skaters in the oldest group (≥17 years) for Health, Coordination, Physical Activity, Body Fat, Sport Competence, Global Physical Self-Concept, Appearance, Endurance, Self-Esteem and Flexibility. Interestingly, among the oldest skaters, those who are pre-elite report lowest mean Sport Competence scores, whereas elite skaters report the highest mean scores on most other subscales.

For the EDI, younger (≤ 15.0 years) test and/or elite skaters report higher mean scores than pre-elite skaters for the majority of the subscales. Among the older skaters, particularly ≥17.0 years, pre-elite and/or elite skaters report higher values than test skaters for all of the EDI subscales. It is also important to note that elite skaters 13-15 years and ≥17 years, and test skaters 15-17 years of age report high mean (≥10) Body Dissatisfaction scores, which is an indicator of eating disorder risk (Garner and Olmstead, 1984). Test skaters report higher mean SPA scores than both pre-elite and elite skaters until 17 years, when elite skaters report higher mean scores. Test skaters have higher SPA than pre-elite skaters until about 17 years, whereas elite skaters have higher SPA scores than test and pre-elite skaters.

Descriptive statistics for the PSDQ, EDI and SPA by level are presented in Table 30. Two MANCOVAs with age as the covariate were conducted for the PSDQ and EDI subscale scores. Results of the MANCOVAs are presented in Table 31. Age covariates are significant for both the EDI and the PSDQ, but only the PSDQ has a significant main effect. After controlling for age, univariate effects are significant for Physical Activity, Appearance, Endurance and Self-Esteem. Post hoc analyses using Tukey's HSD indicate that elite and pre-elite skaters have higher scores than test skaters for Appearance, Endurance and Self-Esteem, while elite skaters have higher scores for Physical Activity than either test skaters or pre-elite skaters. The main effect for the EDI is not significant, but the ANCOVA for SPA is significant. Both test and elite skaters have higher SPA scores than pre-elite skaters.

Of the 37 skaters meeting the Body Dissatisfaction criteria for eating disorder risk classification (scores $\geq$ 10) by level, 30% are test skaters (n = 11), 27% are pre-elite skaters (n = 10) and 43% are elite skaters (n = 16) [χ^2 (2) = 7.0, p < .05). Although there is a significant chi square, the residuals do not meet the cut off of 2.0, which is meaningful for significant cell contribution if the data were randomly distributed (Hinkel et al., 1988). The cells by level range from -1.1 to 1.7. Of the 15 skaters meeting the Drive for Thinness criteria (scores $\geq$ 15), 33% are test skaters (n = 5), 20% are pre-elite (n = 3) and 47% are elite (n = 7) [χ^2 (2) = 4.1, p > .05].

H6: There is a greater proportion of late maturing pre-elite and elite skaters than test skaters.

This analysis is limited to 67 figure skaters $\geq$ 16 years of age. Recalled ages at menarche and means and standard deviations are summarized in Table 32. The mean age at menarche, is significantly later for elite skaters (14.0 $\pm$1.4) compared to test skaters (12.9 $\pm$ 0.8) [F(2) = 6.0, p $\leq$ .01]. Pre-elite skaters do not differ from elite or test skaters. Contrary to the hypothesis, a significant chi square analysis for age at menarche by level [χ^2 (2) = 7.3, p $\leq$ .05] indicates that there are more average maturing (menarche about 11.8 to14.0 years) skaters across all three competency levels (test: 92.9%, pre-elite skaters:

81.3% and elite: 70.8%). However, examining the residuals of each cell in the analysis to determine, if any are ≥ 2.0, reveals none that are significant (range: -0.3 - 1.3).

Question 3

Do the physical and psychological characteristics of competitive skaters differ across discipline (free skate, dance and pairs)?

H7: Dancers are older, taller and leaner, and have relatively longer legs than free skater and pair skaters.

Physical Characteristics

Age-related trends in anthropometric characteristics across discipline were initially examined age groups (Table 33). Among the younger skaters (11-14 years), dancers and pair skaters are generally lighter, have lower a BMI, and have a shorter sitting height and lower sitting height/stature ratios than free skaters. Free skaters are shorter in stature and have shorter relative leg length than dancers and pair skaters. Compared to free skaters, older dancers and pair skaters are lighter, shorter in stature, sitting height and leg length, and have shorter relative leg lengths than dancers. Younger (≤ 15.0 years) pair and free skaters are slightly broader in skeletal breadths than dancers, while dancers and free skaters are broader than pair skaters among the older skaters (≥ 15.0 years). Except among 11-12 year old skaters, dance and pair skaters are generally smaller than free skaters in limb circumferences and skinfolds across age, which partially supports the hypothesis.

Older dancers ($\geq$ 15.0 years) tend to be more ectomorphic and pair skaters are more mesomorphic to about 17 years. Among the oldest skaters ($\geq$17 years), pair and free skaters are identical in mesomorphy, dancers are more ectomorphic, and free skaters are more endomorphic (Table 33).

A significant ANOVA [$F(2) = 4.8$, $p < .01$] indicates that dancers (16.8 $\pm$ 2.5) are older than free skaters (15.3 $\pm$ 2.3), but not pair skaters (16.1 $\pm$ 2.6). After controlling for age, ANCOVAs were significant for all variables except estimated leg length, bicondylar breadth, the biceps skinfold, and the T/E ratio. Post hoc analyses reveal that free skaters are heavier and taller than dancers and pair skaters. They also have a larger BMI and sitting height, and a higher the sitting height/stature ratio than pair skaters. Dancers are larger than pair skaters in stature, sitting height, and have a higher sitting height/stature ratio. Free skaters are broader than pair skaters and dancers in biepicondylar breadth. For all circumferences, free skaters are larger than either dancers or pair skaters, with free skaters larger than dancers in corrected arm circumference. For skinfold thicknesses, free skaters have more subcutaneous fat than either dancers or pair skaters at the triceps, supraspinale, abdominal and calf sites and the sum of 6 skinfolds, and have more fat than pair skaters at the subscapular site. Pair skaters have a thicker medial calf skinfold than dancers (Table 34 and 35).

Mean somatotypes by discipline are presented in Figure 17. MANCOVAs were conducted for each somatotype component by discipline with age and the two other somatotype components as covariates. Post hoc comparisons were conducted using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 (Cressie et al., 1986). Results indicate that free skaters are more endomorphic than both dancers and pair skaters, and pair skaters are more mesomorphic than free skaters and dancers. Ectomorphy does not differ by discipline (Table 34 and 35).

H8: Dancers and pair skaters have more favorable self-concept scores, but are at greater risk for eating disorders than free skaters.

Psychological Characteristics

Means for each psychological inventory subscale by discipline and age group are presented in Table 36. Partially supporting the hypothesis, free and pair skaters generally report greater PSDQ subscale scores than dancers until about 17 years, and dancers report highest mean scores for the subscales of Body Fat, Global Physical Self-Concept and Appearance. Contrary to what was expected, pair skaters report lowest scores for these subscales and for Self-Esteem.

Age-related trends indicate, in general, that free skaters and dancers report higher mean EDI scores than pair skaters to about 17 years of age. Among the oldest skaters ($\geq$ 17 years), dancers and pair skaters generally report the highest mean scores. Dancers 15.0-16.9 years and pair skaters $\geq$ 17 years report high ($\geq$10) Body Dissatisfaction scores. Free skaters report the highest scores until 17 years after which free skaters report highest mean SPA scores.

Descriptive statistics for the PSDQ, EDI, and SPA in the total sample of figure skaters by discipline are presented in Table 37. Two MANCOVAs controlling for age were conducted to determine if skaters differed in the PSDQ and EDI across discipline. The age covariates and main effects are significant for both analyses (Table 38). After controlling for age, univariate analyses for discipline are significant for Health, Coordination, Sport Competence, and Strength. Post hoc analyses indicate that free skaters report higher Health scores than dancers or pair skaters, whereas free and pair skaters report higher scores than dancers for Coordination, Sport Competence and Strength. The results partially support the hypothesis that more specialized skaters have more favorable self-perceptions.

After controlling for age, there are significant univariate effects for the Bulimia and Interpersonal Distrust scores of the EDI. Dancers report higher values on both subscales than both free and pair skaters, which provides partial support for the hypothesis. Pair skaters do not report values higher than free skaters. Results of the ANCOVA indicate that SPA does not differ by discipline ($F(2, 134) = 0.3$, $p \geq .05$).

Of the 37 skaters meeting the Body Dissatisfaction criteria for eating disorder risk classification (scores $\geq$ 10), 62% are free skaters (n = 23), 24% are dancers (n = 9), and 14% are pair skaters (n = 5) [χ^2 (2) = 1.4, $p > .05$]. Of the 15 skaters meeting the Drive for Thinness criteria (scores $\geq$ 15), 47% are free skaters (n = 7), 27% are dancers (n = 4), and 27% are pair skaters (n = 4) [χ^2 (2) = 3.8, $p > .05$].

H9: There is a greater proportion of late maturing dance and pair skaters than free skaters.

The analysis is limited to 67 figure skaters $\geq$ 16 years of age because all but one skater are post-menarcheal. The distribution of recalled ages at menarche, and means and standard deviations are summarized in Table 39. Mean recalled age at menarche is significantly later in pair skaters (14.5 $\pm$ 1.3 years) compared to free skaters (13.4 $\pm$ 1.0 years) and dancers (13.4 $\pm$ 1.4) ($F(2) = 4.7$, $p \leq .01$). A significant chi square analysis [χ^2 (2) = 6.1, $p \leq .05$] and a residual of 1.9 for late maturing pair skaters, although not significant, suggests a trend for a greater proportion of late maturing pair skaters (58%) than would be expected if the data were randomly distributed. In contrast, 21% of free skaters and 25% of dancers are late maturing, and the residuals for the average and late maturing skaters by discipline range from -1.2 to 0.6.

Question 4

Do the physical and psychological characteristics of figure skaters differ relative to menarcheal status and timing?

H10: Pre- and post-menarcheal skaters differ in physical and psychological characteristics.

Physical Characteristics

Descriptive statistics for pre- and post-menarcheal skaters are shown in Table 40. ANCOVAs controlling for age (Table 41) were conducted for the anthropometric characteristics of pre- and post-menarcheal skaters. After controlling for age, the univariate analyses are significant for all variables except biepicondylar breadth, relaxed arm, corrected arm and calf circumferences, and the T/E ratio. Pre-menarcheal skaters are smaller than post-menarcheal skaters in all anthropometric variables. They have, however, proportionately longer legs.

MANCOVAs were used to compare somatotype by menarcheal status holding age and the two other somatotype components constant. Post hoc comparisons conducted using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 (Cressie et al., 1986) indicate that pre-menarcheal skaters are less endomorphic and more ectomorphic than post-menarcheal skaters. Mesomorphy did not differ.

Psychological Characteristics

Descriptive statistics for the psychological inventories in skaters by menarcheal status are presented in Table 42. Two MANCOVAs controlling for age were conducted to determine if skaters differed in PSDQ and EDI subscales by menarcheal status. Age is a significant covariate for the PSDQ, but not for the EDI. The main effects for both analyses are significant (Table 43). Univariate statistics for the Body Fat, Sport Competence, Global Physical Self-Concept, Endurance and Self-Esteem subscales of the PSDQ are significant. Pre-menarcheal skaters have higher scores for each. After controlling for age, univariate analyses for the subscales of the EDI are significant for Body Dissatisfaction, Drive for Thinness, and Introceptive Awareness, and post-menarcheal skaters have higher scores than pre-menarcheal skaters for each of these subscales. Post-menarcheal skaters also have significantly higher SPA scores than pre-menarcheal skaters.

Of the 37 skaters meeting the Body Dissatisfaction criteria for eating disorder risk (scores ≥ 10), 97% are post-menarcheal ($n = 36$) and only one skater is pre-menarcheal skater (3%) ($n = 1$) [χ^2 $(1) = 16.2$, $p < .001$]. A residual of -2.9 for pre-menarcheal skaters indicates that a smaller proportion of pre-menarcheal skaters meet the Body Dissatisfaction criteria than would be expected if the data were randomly distributed.

Of the 15 skaters meeting the Drive for Thinness criteria for eating disorder risk classification (scores ≥ 15, respectively), 93% are post-menarcheal ($n = 14$), and only one skater is pre-menarcheal (7%) [$\chi^2(1) = 3.7$, $p = .05$]. Despite the significant chi square, none of the residuals (-1.5 to 1.0) meet the 2.0, cut-off which is considered a significant contribution to the chi square analysis (Hinkel et al., 1988).

H11: Pre-menarcheal skaters differ in physical and psychological characteristics by age group.

Physical Characteristics

Pre-menarcheal skaters were grouped into three age categories: 11:00-11.99; 12.00-13.99, 14.00-15.99 years. ANCOVAs, controlling for age, were conducted to test for age group differences in anthropometric characteristics. F-ratios are significant only for sitting height and sitting height/stature ratio (Table 44). Skaters 11.00 -12.99 years are shorter than skaters 14.00 - 15.99 years in sitting height, and have a lower sitting height/stature ratio than skaters 12.00 - 13.99 years. The MANCOVAs for somatotype are not significant.

Psychological Characteristics

Results of the ANCOVAs, controlling for age, and descriptive statistics of the PSDQ and EDI subscales and SPA are shown in Table 45. There are no significant differences in any of the psychological variables.

H12: Later maturing post-menarcheal skaters are shorter, lighter and leaner than earlier maturing post-menarcheal skaters.

Physical Characteristics

Skaters $\geq$16 years classified as average or "on-time" (recalled age at menarche $\leq$ 14.0 years) were compared to skaters $\geq$16 years classified as late (recalled age at menarche $\geq$ 14.0 years). Descriptive statistics for the two groups are presented in Table 46. Results of the ANOVAs indicate significance differences between average and late maturers for sitting height, the sitting height/stature ratio, calf circumference, biceps, subscapular and abdominal skinfolds and the sum of 6 skinfolds. Although younger, on average, by one year, average maturing skaters are taller in sitting height, have proportionately shorter legs, larger calf circumferences, and greater skinfold thicknesses, than late maturing skaters. The MANCOVA for somatotype is significant only for endomorphy. Average maturing skaters are more endomorphic than late maturing skaters (Table 46).

H13: Earlier maturing post-menarcheal skaters report less favorable psychological characteristics than later maturing post-menarcheal skaters.

Psychological Characteristics

Results of the ANOVAs and descriptive statistics for the psychological variables are shown in Table 47. The results indicate significant differences between average and late maturers for the Coordination, Endurance and Self-Esteem subscales of the PSDQ. Late maturers have higher scores for the three subscales. Contrary to what was expected, there are no differences between average and late maturers in the EDI subscales, or SPA.

Of the 24 skaters meeting the Body Dissatisfaction criteria for eating disorder risk (scores $\geq$ 10), 75% are average maturing skaters (n = 18) and 25% are late maturing (n = 6) [$\chi^2(1) = 0.0$, $p < .05$]. The residuals = 0.0 for each cell. Of the 10 skaters meeting the Drive for Thinness criteria (scores $\geq$ 15), 70% are average maturing (n = 7) and 30% are late maturing (n = 3) [$\chi^2 (1) = .1$, $p < .05$]. The residuals range from -0.2 to 0.3.

Question 5

Are the physical characteristics of figure skaters correlated with self- perceptions of physical dimensions?

H14: Anthropometric dimensions related to size, proportions and fatness are negatively correlated with selected psychological variables related to perceptions of physical characteristics, including PSDQ subscales (Body Fat, Global Physical Self-Concept Appearance, and Self-Esteem), and positively correlated with EDI subscales (Drive for Thinness, Bulimia, Body Dissatisfaction, and Maturity Fears), and Social Physique Anxiety.

Partial correlations, controlling for age, were done among the following selected physical variables: weight, stature, sitting height, the sitting height/stature ratio, estimated leg length, sum of 6 skinfolds, and somatotype, and psychological variables: PSDQ subscales - Body Fat, Appearance, Self-Esteem and Global Physical Self-Concept; EDI subscales - Drive for Thinness, Bulimia, Body Dissatisfaction, and Maturity Fears; and Social Physique Anxiety (Table 48). Each of the psychological variables was selected because psychological risk factors, including negative perceptions of physical characteristics, social physique anxiety, and factors related to problem eating are suggested as related to the morphological changes associated with puberty (Brooks-Gunn, 1988; Crocker and Snyder, 1996; Eklund and Crawford, 1994; Marsh, et al., 1995; Martin et al., 1997).

Anthropometric variables are significantly correlated with the psychological variables. Significant correlations range from -0.17 to 0.54, and the valences are in the expected directions. With the exception of Appearance, Maturity Fears and Perfectionism, correlations are low to moderate (-0.17 to 0.69) between weight and stature and all psychological variables. Weight and stature are positively correlated with Body Fat, Body Dissatisfaction, Drive for Thinness, Bulimia and SPA, and negatively correlated with Global Physical Self-Concept and Self-Esteem. Correlations between the sum of 6 skinfolds and Body Dissatisfaction and Drive for Thinness are also positive and low to moderate, while correlations between the sum of 6 skinfolds and Body Fat and Global Esteem are negative and low to moderate (-0.11 and -0.49). The correlations for somatotype components are fourth order partial correlations controlling for age and the two other components. The only significant correlations are a low positive correlation between ectomorphy and Global Physical Self-Concept (0.22) and a moderate negative correlation between endomorphy and Body Fat (-0.32).

H15: Controlling for height, weight, and/or subcutaneous fatness, variables that are positively correlated during adolescence, reduces the correlations between the physical and psychological variables.

When age and weight are statistically controlled, the correlations between height and Body Fat is low but significant (0.20). However, the correlations between height and Global Physical Self-Concept, Self-Esteem, Body Dissatisfaction, Drive for Thinness, Bulimia and SPA diminish and are not significant when age and weight are statistically controlled (Table 49). Similarly, when age and height are controlled, the only significant correlation for the sum of 6 skinfolds is a low, negative correlation (-0.20) with Body Fat; the correlations with Global Physical Self-Concept, Body Dissatisfaction, Drive for Thinness and SPA are reduced and not significant.

On the other hand, when age and height are statistically controlled, the correlation between weight and Body Fat, Global Physical Self-Concept and Self-Esteem are significant, negative, and low to moderate (-0.20 to -0.44). The correlations suggest that that heavier skaters are less satisfied with their Body Fat and have low Global Physical Self-Concept and Self-Esteem. The correlations between weight and Body Dissatisfaction (0.34) and SPA (0.25) are significant and positive, suggesting that heavier skaters are at greater risk for eating disorders and have higher anxiety about their physique. The relationships between weight and Drive for Thinness and Bulimia are no longer significant. Overall, the results support the hypothesis.

Question 6

Can a selection of physical and psychological characteristics thought to be important for the elite level of figure skating discriminate level of competency and disciplinary involvement?

The following variables were considered as representative of the physical and psychological characteristics of elite figure skaters: height, weight, the sitting height/stature ratio, somatotype (endomorphy, mesomorphy, ectomorphy), Self-Esteem, Body Dissatisfaction, Drive for Thinness, Perfectionism, and SPA. Age at menarche and Maturity Fears were also included in the discriminant function analyses for post-menarcheal skaters ≥ 15 years. Due to missing data, the sample size was reduced significantly ($n \leq 114$), and the dancers and pair skaters were combined to represent 'specialized' skaters for the analysis by discipline.

H16: Physical and psychological variables can discriminate level of competency among figure skaters.

Of the 114 skaters, 33 are test level, 47 are pre-elite and 34 are elite skaters. The Wilks' Lambda procedure was employed to identify a reduced set of predictors of group membership. The discriminant function analysis significantly differentiates test, pre-elite and elite skaters (Wilks' Lambda = 0.84, $\chi^2(2) = 19.2$, $p \leq .001$). The group centroids are 0.67, -0.31, and -0.22 for test, pre-elite and elite skaters, respectively. Age and endomorphy are the two discriminating variables (Table 50). No psychological variables are represented. Elite skaters (17.5 ± 2.2 years) are older than either test (15.4 ± 1.8 years) or pre-elite skaters (15.1 ± 2.2 years), and test skaters are more endomorphic (3.9 ± 1.0) than either pre-elite (2.8 ± 0.9) or elite (3.4 ± 1.0) skaters.

The effectiveness of the discriminant analysis was assessed using equal probabilities. This method allows subjects to be categorized by level based on knowing the responses on the discriminating variables (age and endomorphy). Using this method, only 58% of the skaters are correctly classified (Table 50).

H17: Physical and psychological variables can discriminate the disciplinary involvement of figure skaters.

By discipline, 72 of the skaters specialize in free skating, and 42 specialize in dance or pair skating. The discriminant function analysis significantly discriminates the two groups (Wilks' Lambda = 0.83, $\chi^2(2) = 21.3$ $p \leq .001$). The group centroids are 0.34 and -0.62 for free skaters and specialized skaters, respectively. Endomorphy and age discriminate skaters by discipline, classifying 66% of the skaters correctly (Table 50). None of the psychological variables are significant discriminators. Dance and pair skaters are older (16.5 $\pm$ 2.4 years) and less endomorphic (2.9 $\pm$ 0.8) than free skaters (15.6 $\pm$ 2.2 years, and 3.6 $\pm$ 1.1, respectively).

To determine if age and endomorphy discriminate among the more elite skaters, test skaters were removed and another discriminant function analyses was performed. Mesomorphy and ectomorphy were also included since the three somatotype components must be considered together. The total sample was reduced to 90 with 49 skaters specializing in free skating and 41 skaters specializing in dance or pair skating. Results are presented in Table 50. Endomorphy and age correctly classified about 62% of the skaters by discipline (Wilks' Lambda = 0.88, $\chi^2 = 16.73$, $p < .05$). The group centroids are 0.33 and - 0.39. Among the pre-elite and elite skaters, dance and pair skaters are older (16.5 $\pm$ 2.3) and less endomorphic (2.9 $\pm$ 0.8) than free skaters (15.5 $\pm$ 2.5, 3.3 $\pm$ 1.1, respectively).

H18: Level of competency and disciplinary involvement are discriminated by different sets of variables in post-menarcheal figure skaters $\geq$15 years.

Since the median age at menarche is 14.2 $\pm$ 0.5 years, and the majority of skaters $\geq$15 years are post-menarcheal, the analysis was limited to post-menarcheal skaters $\geq$15 years. Three15 year old skaters and one 16 year old skater had not yet attained menarche, reducing the sample size to 69 post-menarcheal skaters $\geq$ 15 years. Age at menarche and Maturity Fears were also included in the analysis.

Twenty skaters are test level, 19 are pre-elite, and 30 are elite skaters. Endomorphy, age and Self-Esteem discriminate test (n = 19), pre-elite (n = 20) and elite (n = 30) post-menarcheal skaters (Wilks' Lambda = 0.56, $\chi^2(6) = 37.6$, $p \leq .001$), thus partially supporting the hypothesis. The group centroids are -1.2, 0.48, and 0.48, respectively (Table 51). This combination of variables correctly classifies 68% of the skaters correctly which is a greater percentage than in the total sample (58%). Elite skaters are older (18.1 $\pm$ 1.7 years) and have higher Self-Esteem (6.1 $\pm$ 0.7) than pre-elite skaters (17.1 $\pm$ 1.4 years and 5.9 $\pm$ 0.8, respectively) and test skaters (16.7 $\pm$1.1 years and 5.4 $\pm$ 0.9, respectively), while pre-elite skaters are less endomorphic (3.1 $\pm$ 1.0) than test (4.3 $\pm$ 0.7) and elite (3.5 $\pm$ 0.9) skaters (Table 51).

By discipline, 42 of skaters specialize in free skating and 27 specialize in dance and pair skating. Endomorphy and age discriminate free skaters from the specialized skaters (Wilks' Lambda = 0.78, $\chi^2(2) = 20.2$, $p \leq .001$). The group centroids are 0.38 and -.71, respectively, classifying 69% of the skaters correctly (Table 51). This analysis correctly classifies an additional 3% of the skaters compared to the analysis in the total sample. No psychological variables entered the discrimination significantly. Specialized skaters are older (17.5 $\pm$ 1.8 years) and less endomorphic (3.1 $\pm$ 0.8) than free skaters (16.3 $\pm$ 2.0 years and 4.0 $\pm$ 0.9, respectively).

After removing test skaters from the sample of post-menarcheal skaters $\geq$ 15 years of age, the sample was reduced to 50 with 28 skaters specializing in free skating and 22 skaters specializing in dance or pair skating. The discriminant function analysis significantly discriminates the two groups (Wilks' Lambda = 0.90, χ^2 (2) = 5.3, $p \leq .05$). The group centroids are 0.36 for free skaters and -0.29 for dance and pair skaters.

Endomorphy discriminates the more elite skaters by discipline correctly classifying 64.0% of the skaters correctly. Dance and pair (3.1 $\pm$ 0.7) skaters are less endomorphic than free skaters (3.6 $\pm$ 1.1) (Table 51).

Question 7

Can self-perceptions characterized by Social Physique Anxiety, Global Physical Self-Concept, and Self-Esteem be predicted by a unique set of physical and psychological variables?

H19: Self-concept is predicted by a combination of physical and psychological variables.

The relationships among variables reflecting self-concept and its psychobiological sources was examined. A multivariate-multiple regression analysis was performed to determine if psychological variables reflecting self-concept, which include SPA, Global Physical Self-Concept and Self-Esteem, could be could be predicted by a combination of physical and psychological characteristics. Due to the sample size (n = 114), the set of predictor variables, was limited to age, height, weight, somatotype (endomorphy, mesomorphy, ectomorphy), Appearance, Body Fat, Body Dissatisfaction, Drive for Thinness, and Perfectionism. The three constructs representing self-concept were chosen because these variables are considered essential for athletic success, especially for those participating in aesthetic sports (Crocker and Snyder, 1997). Having low SPA and high Global Physical Self-Concept and Self-Esteem are presumably important for presenting oneself in front of coaches, judges, spectators and others who are important in the selection of elite, specialized skaters.

To determine the relationship between self-concept and the hypothesized psychobiological sources, Pearson-product moment correlations were calculated. The significant correlations are low to moderately high, ranging from -0.27 to 0.73. Thus, assumptions regarding within set multicolinearity ($r < 0.80$), are met. Each variable correlates significantly with at least one self-concept subscale, with the exception of mesomorphy and endomorphy, which do not correlate with any of the self-concept subscales (Table 52). However, the three components collectively define an individual's somatotype, and were thus retained in the analysis. Body Dissatisfaction, Drive for Thinness, Body Fat, Appearance, ectomorphy, height and weight correlate significantly with each of the self-concept subscales; age significantly correlates with SPA and Global Physical Self-Concept; and Perfectionism correlates significantly with SPA. The correlations are also in the expected direction, i.e., skaters who are heavier and taller, skaters and those who have higher Body Dissatisfaction and Drive for Thinness scores have less favorable self-concept scores compared to skaters who are leaner and smaller, and who report more favorable self-concept scores.

The variables that showed a significant relationship with any of the self-concept subscales were entered into a multivariate-multiple regression analysis to assess the relative strength of their predictiveness to the self-concept subscales. As noted above, the three somatotype components were also entered into the regression because somatotype must be treated as a unit. Results of the overall multivariate regression analysis is significant (Wilks' Lambda = 0.15, $F(33) = 8.2$, Eta = 0.85, $p < .001$), and the univariate regression analyses indicate that each of the three equations are significant: SPA ($F(11,102) = 12.3$, $R^2 = .52$), Global Physical Self-Concept ($F(11,102) = 26.2$, $R^2 = 0.71$), and Self-Esteem ($F(11,102) = 9.6$, $R^2 = 0.51$).

In addition to the regression procedures, the relationship between the self-concept subscales and the set of psychobiological variables was evaluated with canonical correlation analyses. When canonical correlates are squared, there is more than 10% overlap, which is a meaningful proportion of variance (Tabachnick and Fidell, 1996). Two canonical relationships are significant (rc1 = 0.89, rc2 = 0.48) and the overlapping variances are 79% and 23%, respectively.

A summary of the standardized canonical coefficients and canonical loadings is presented in Table 53. The first canonical variate pair extracts 70% of the variance from the self-concept variate and 24% of the psychobiological variate. The second canonical variate pair accounts for 18% of the variance from the self-concept variate and only 2% of the psychobiological variate. Together, the two canonical variates account for 88% of the variance in the self-concept variate and 26% of the variance in the psychobiological variate. Considering the redundancies, the first psychobiological variate accounts for 55% of the variance in self-concept, while the second variate accounts for only 4%, together accounting for 59% of the variance in self-concept. However, since the redundancy of the second variate does not meet the 10% cut-off, which is considered a meaningful proportion of variance (Pedhuzur, 1982), it is not interpreted further. The first self-concept variate accounts for 31% and the second 8% of the variance in the psychobiological variate. Together the two self-concept variates overlap the variance in the psychobiological variate by 39%.

Canonical loadings were examined to determine which specific variables in each psychobiological variate contributed to the self-concept multivariate relationship.

Inspection of the canonical loadings for the canonical variates in Table 53 indicate that nine of the psychobiological variables are important contributors to the variables characterizing self-concept (cut-off ≥ 0.30) (Tabachnick and Fidell, 1996). For the significant variate, age, height, weight, ectomorphy, Body Fat and Body Dissatisfaction contribute to self-concept. Drive for Thinness (0.37 and 0.51, respectively) and Appearance (-0.77 and 0.34, respectively) cross load on both variates and are thus excluded. Since this set of variables involves biological variables and psychological variables related to physical perceptions, it is labeled as 'bio-perceptual'.

The loadings for the dependent variables indicate that SPA, Global Physical Self-Concept and Self-Esteem are important contributors to the first canonical variate. Thus, based on the valences of the correlations (Table 53), older skaters who are taller, heavier, less ectomorphic, less satisfied with their Appearance and Body Fat, and who have higher Body Dissatisfaction, have higher SPA and lower Global Physical Self-Concept and Self-Esteem (Figure 18).

<u>Question 8</u>

Can the susceptibility to eating disorders identified by Bulimia, Drive for Thinness, Body Dissatisfaction, Perfectionism and Maturity Fears be predicted by anthropometric characteristics, somatotype and psychological variables related to physique, appearance and self-concept?

H20: A combination of anthropometric characteristics, somatotype and psychological variables related to physique, appearance and self-concept predicts the five eating disorder subscales.

Five subscales of the EDI were chosen as representing risk for eating disorders in adolescent figure skaters. Bulimia was chosen because it is the only behavioral indicator of disturbed eating patterns represented in EDI. Drive for Thinness and Body Dissatisfaction involve physical self-perceptions. The perception of maturity (Maturity Fears) is also of interest. Since expectations of perfection are inherent in skating, Perfectionism was also considered. The three remaining constructs (Ineffectiveness, Introceptive Awareness, and Interpersonal Distrust) are concerned with social adjustment and are not relevant to this athletic context; therefore, they were excluded from the analysis.

Five separate stepwise regression analyses were conducted to determine if physical and psychological variables predict the five EDI subscales. Age was forced into each analyses at step 1 and the remaining variables were entered at random. Physical predictor variables included height, weight, the sitting height/stature ratio, endomorphy, mesomorphy and ectomorphy, while the psychological variables included SPA and the PSDQ subscales: Appearance, Body Fat, Health, Global Physical Self-Concept, and Self-Esteem.

Results of the regression analyses are summarized in Table 54. Consistent with the hypotheses, each EDI subscale is predicted by at least one physical variable and at least one psychological variable with the exception of Bulimia. The correlations between the EDI subscales and the predictor variables are low to moderate, with the exception of Body Dissatisfaction and SPA ($r = 0.80$), excluding mutlicolinearity among variables. The magnitude of the Beta weights range from 0.02 to 0.57, and are in the expected directions. For example, weights for perceptions of Bulimia and Health, Body Dissatisfaction and

Global Physical Self-Concept, and Drive for Thinness and endomorphy are negative, while weights for SPA and all EDI indicators are all positive. The proportion of variance accounted for by age ranges from 0 to 9%, by physical characteristics from 3% to 15%, and by psychological characteristics range from 2% to 47%. The total variance accounted for by all indicators ranges from 14% to 65%.

Summary of the Results

A summary of the results of each hypothesis is presented in Table 55. Most of the hypotheses are either supported or partially supported. Eight of the 20 hypotheses were supported, eight were partially supported, and four were not supported.

Figure skaters are generally below U.S. reference values for anthropometric variables. Early maturation is underrepresented in this sample, and skaters are generally later maturing than North American girls. With the exception of the Physical Activity subscale score, PSDQ scores decrease with age, while SPA and EDI scores increase with age. PSDQ scores of figure skaters are higher, while SPA and EDI scores are lower compared to samples of non-athletes.

Comparisons across test, pre-elite and elite levels of competency indicate that more elite skaters are generally shorter, lighter and, leaner, and smaller in circumferences and skeletal breadths than test skaters. Elite and pre-elite skaters are less endomorphic than test skaters, and elite skaters are less ectomorphic than both test and pre-elite skaters. Contrary to expectations, there are more average maturing than late maturing skaters across all three levels of competency, but elite skaters are significantly later maturing than test skaters. The PSDQ scores of more elite skaters are higher than those for test skaters; test and elite skaters had higher SPA scores than pre-elite skaters. There are no differences in EDI scores by level of competency.

Comparisons across free, dance and pair skating disciplines indicate that dancers are older, taller and leaner, and have relatively longer legs than free and pair skaters. Contrary to the hypothesis, there is not a greater proportion of late maturing dance and

pair skaters than free skaters. However, there is a trend for more later maturing than average maturing skaters among pair skaters. Pair skaters are significantly older at menarche than both dancers and free skaters. Free and pair skaters have higher PSDQ scores than dancers, and dancers have higher EDI scores than both free and pair skaters. SPA scores do not differ across discipline.

Pre-menarcheal skaters are taller, smaller, less endomorphic, and more ectomorphic than post-menarcheal skaters. They also have higher PSDQ scores, and lower SPA and EDI scores. There are no significant age-group differences for anthropometric variables in pre-menarcheal skaters, but younger skaters have higher PSDQ scores, and lower SPA and EDI scores.

Late maturing post-menarcheal skaters ≥ 16 years of age are thinner, have relatively longer leg length, and have smaller limb circumferences than average maturing skaters. Average maturing skaters report higher PSDQ scores, but EDI or SPA scores do not differ by maturity group.

Selected anthropometric dimensions related to size, proportions and fatness are negatively correlated with selected psychological variables related to perceptions of physical characteristics when age is statistically controlled. Most of the significant correlations between height and psychological variables are reduced when age and weight are statistically controlled; results are similar for correlations between weight and psychological variables when age and sum of 6 skinfolds are controlled. When age and height are statistically controlled, correlations between weight and psychological variables remain significant.

Age and endomorphy correctly classify 58% of the skaters by level and 66% of the skaters by discipline. Contrary to expectation, no psychological variables classified the total sample of skaters by level or discipline. However, analysis of data for skaters $\geq$ 15 years of age, endomorphy, age and Self-Esteem correctly classified 68% of the skaters by level. In contrast, age and endomorphy correctly classified 69% of the skaters $\geq$ 15 years of age by discipline. When test skaters were removed from the analysis, age and endomorphy correctly classified 62% of the total sample of skater by discipline and only endomorphy classified 64% of the skaters $\geq$ 15 years of age; the more specialized dance and pair skaters were older and/or less endomorphic than free skaters.

A combination of physical (age, height, weight and ectomorphy) and psychological variables related to physical perceptions (Body Fat, Body Dissatisfaction) predicted self-concept accounting for 55% of the variance in self-concept. This combination of variables was labeled 'bio-perceptual'. A combination of physical and psychological variables also predicted selected EDI subscale scores. Total variances accounted for ranged from 14% to 65%.

CHAPTER V

Discussion

As the number of skaters in North America increases, skaters pursuing elite status are becoming younger. For example, Ekaterina Gordieva, Michelle Quan and Tara Lapinski each stood on the podium at the end of their respective 1988, 1994 and 1998 Olympic competitions. Each skater was under the age of 16. In addition to the pressures associated with adolescent growth and maturation, young skaters must endure the pressures associated with the subjective evaluation inherent in this sport. Integral to scoring well in skating is the skater's ability to present herself in a manner that demonstrates grace, amplitude, power, speed, and strength to those judging the sport. As such, maintenance of a petite, attractive physique, in combination with strength and power are critical components of the sport.

The purpose of the present study was to examine the physical and psychological characteristics of a heterogeneous sample of figure skaters. Central issues were the characteristics of successful skaters compared to those who are less successful, and of those who compete in free, dance and pair skating. Differences associated with variation in maturational timing, the concordance between objectively measured physical characteristics and subjective self-perceptions, and predictors of eating disorder risk were also considered.

The results of this study may be used to identify characteristics unique to each skating discipline and to those who are more successful. However, it cannot be assumed or implied that successful young skaters with such profiles will eventually develop into elite skaters. Because the developmental pool in figure skating is small compared to many other sports, coaches should not discourage any figure skater to continue (Klika, 1995).

Demographic Characteristics

This sample of competitive figure skaters entered organized sport (4.9 ± 1.9 years) and organized skating (5.4 ± 2.1 years) at slightly younger ages than Junior Olympic divers (5.6 ± 1.8 and 6.0 ± 1.7 years, respectively) (Malina and Geithner, 1993). They were also younger than the general population of American children. It is not until about seven years of age that American children have their first organized sport experience (Malina, 1997; Seefeldt, 1978). Figure skaters in this study had already begun specializing in skating by a mean age of 8.7 ± 2.4 years, and had an average of 10 years of experience at the time of data collection. As expected, years of experience in organized figure skating, and within a specific skating discipline, increased with age. Consistent with Scanlan et al. (1989a), skating specialization is exclusionary; only 11% of the skaters reported participation in other sports.

Parents played a fundamental role in influencing skating participation, followed by coaches, friends and events such as the Olympics. Skaters came from relatively small families, and few reported living away from home. The financial commitment involved in figure skating is extensive, particularly at more specialized and elite levels. Ice time, coaching, music, choreography, dance training and clothing bills accumulate and can cost as much as $50, 000.00 a year (G. McClelland, 1999, personal communication). Only 6% of this sample of skaters received funding, and 14.5% lived away from home. However, the socioeconomic status of the families of the skaters appeared to be middle to upper class based on the education levels of mothers and fathers. Most mothers and fathers attended university and had undergraduate or graduate degrees.

The majority of skaters in this study were pre-elite, which was not surprising. Pre-elite skaters compete at the pre-novice and novice levels, which are described by Comper (1991) as the initial stage of figure skating selection. Skaters participating at the pre-elite level represent the pool from which several will be eventually selected for more elite levels of training and competition. Others will move down to the test level and/or leave the sport.

Elite skaters in the present study had significantly more years of experience (12.5 $\pm$ 2.7 years) compared to both pre-elite (9.4 $\pm$ 2.6 years) and test skaters (9.4 $\pm$ 2.8 years) (Table 13). These estimates are consistent with Ericsson et al. (1993), who assert that a minimum of 10 years of deliberate practice discriminates more successful athletes from other participants. However, it is important to note that not all of the skaters are successful and some of the elite skaters have less than 10 years of experience. The results are also consistent with Starkes et al. (1996), who reported that the average number of years to attain the Gold (most advanced) test level among Canadian skaters was 11.2 $\pm$ 2.5 years. Differences in training and competition schedules also discriminated elite skaters from those who were less successful; both practice and competition time increased with competency level.

As figure skating becomes more specialized, there are fewer participating skaters. This trend was apparent in the present study (Table 7). There were significantly more free skaters than either dancers or pair skaters. This may reflect the limited availability of male partners, specialized coaching, and/or training facilities across North America. Pair skaters had more disciplinary and overall experience than free skaters in the present sample. Skaters in the more specialized dance and pair skating disciplines generally practiced more both on- and off-ice, and attended more competitions. The positive relationship between level of competency and practice time is consistent with previous figure skating research (Brooks-Gunn, 1988; Scanlan et al., 1989a; Starkes et al., 1996).

Physical Characteristics

While the growth and physique characteristics of young athletes have received much of attention in the sport sciences, the information available on figure skaters is limited (Malina, 1994). The available data on figure skaters often fail to consider age variability within samples and often treat free, dance and pair skaters as single samples. As hypothesized, competitive figure skaters in this study were, on average, close to, or below the reference medians in several of the anthropometric variables including stature (Figure 2) and weight (Figure 3). This is generally consistent with previous studies (Comper, 1991; Ross et al., 1977; Weaver and Thompson, 1981) (Table 56). One study of 25 elite figure skaters reported mean statures of skaters close to the reference medians (Brooks-Gunn, 1988), but the sample combined skaters 14 to 18 years of age which limits the comparison.

The BMIs of the majority of skaters were between the 15th and 85th percentiles of U.S. reference data, with older skaters having means at, or above the reference medians (Figure 4). BMIs were not reported in the majority of studies and it is not appropriate to estimate a BMI from mean heights and weights. However, the mean BMI in the present sample was similar to data for two samples of skaters (Table 56).

For skaters 12 years of age and older, the mean sitting heights were generally at, or below the reference medians (Figure 5). Absolute leg length in the present study was also less than the reference data (Figure 6), reflecting the short stature of the sample and suggesting that a lower center of gravity may be advantageous for balance and aerial rotation involved in skating (Niinimaa, 1982; Harris, 1986; Ross et al., 1977). The sitting height/stature ratio was higher than the reference medians for older skaters (Figure 7), indicating proportionately shorter leg length.

Mean skeletal breadths (Figures 8 and 9), limb circumferences (Figures 10 and 11) and skinfolds (Figures 12 and 13) were also at, or below the reference medians. The sum of 6 skinfolds of the figure skaters ranged from 29.5 to 124.1mm. Comparison with previous research is not possible because of differences in measurement sites (Comper, 1991; Gledhill and Jamnick, 1992).

Level

It is was anticipated that physical characteristics of skaters could be discriminated by age across competency level (Table 26). Test skaters were heavier than pre-elite skaters and this trend was consistent across age groups. Pre-elite skaters had a lower BMI than either test, or elite skaters across age groups. However, the BMI results should be interpreted with caution since the BMI does not partition fat-free mass from fat mass, and has limited use with young athletes (Malina and Bouchard, 1991).

Test skaters had larger limb circumferences than pre-elite skaters, while elite skaters were larger than pre-elite skater in relaxed arm and thigh circumferences. Pre-elite skaters were also shorter in sitting height and had less subcutaneous fat than elite skaters who were shorter and leaner than test skaters which was also consistent across age. However, only differences between pre-elite and test skaters were significant for skinfold thicknesses. In contrast, the trunk/extremity ratio did not differ across level. In general, the more elite skaters were significantly shorter, lighter, and leaner and had shorter relative leg lengths than test skaters (Table 27). These results suggest that a short stature and leanness are important physical characteristics for attaining elite status (Gledhill and Jamnick, 1992).

Discipline

Free skaters and dancers were larger than pair skaters, and these trends were generally consistent across age groups with the exception of skaters 15 to 17 years for weight and stature. Free skaters had larger BMIs than dancers and pair skaters, but the trend was not consistent across age groups. There was limited variability in the BMI across discipline for skaters $\geq$ 17 year (Table 33).

Free skaters had greater biepicondylar breadths than either dancers or pair skaters, but the trends are not consistent across age groups. Free skaters also had thicker skinfolds than dancers, except for the subscapular skinfold. With the exception of the biceps skinfold, free skaters were also larger than pair skaters in all skinfold thicknesses. Additionally, there were no differences in the trunk/extremity ratio across disciplines. The data suggest that more elite and specialized skaters have less subcutaneous fat than free skaters. Based on the trunk/extremity ratio, skaters seem to carry more subcutaneous fat on their extremities than on their trunk.

Pair skaters were significantly smaller than free skaters in sitting height and had a lower sitting height/stature ratio (Table 34). Free skaters had significantly more subcutaneous fat than pair skaters and dancers which was expected since they rely on their male partners to for lifts and throw-jump technical elements. Although dancers had longer relative leg lengths than test skaters, estimated leg lengths did not differ significantly across level and their proportion of leg length was not longer. This was somewhat surprising since longer legs would presumably accentuate aesthetic lines. However, aesthetic lines may be contingent on the relative proportionality of male skaters. Unfortunately, data on male partners was beyond the scope of this study. In general, these results suggest that more specialized skaters may be selected for their short, light and lean physical characteristics. However, training intensity may also be related to the differences in subcutaneous fatness across discipline; pair skaters and dancers practiced significantly more on the ice than free skaters (Table 14).

Somatotype

Figure skaters tend to be, on average, more mesomorphic than non-athletes; endomorphy and ectomorphy do not consistently differ (Table 57). The overall mean somatotype for figure skaters in this sample was 3.3-3.6-2.8, which is generally consistent with earlier studies of figure (Table 58). The present sample was slightly more endomorphic than other samples of skaters, but it included a broader age range and non-elite skaters. The individual somatotypes of figure skaters were distributed across a broad range of the somatochart, which was not surprising given the heterogeneity of this sample (Figure 26).

Carter and Heath (1990) suggest that the relationship between somatotype variability and level of competition is negative, i.e., the higher the level of competence the more homogenous the sample. Before controlling for age, somatotype variability decreased slightly with increasing levels of competency (Table 27), but this trend was not apparent when age was controlled (Table 28).

After controlling for age, somatotype distinguished between competency level and disciplinary involvement in this sample of skaters. Test skaters were more endomorphic than either pre-elite skaters or elite skaters (Table 28); however, pre-elite and test skaters were more ectomorphic than elite skaters. Compared to two previous studies on elite figure skaters (Ross et al., 1977; Weaver and Thompson, 1981), elite skaters in the present study were more endomorphic and less mesomorphic. Elite skaters were also more ectomorphic than data for elite skaters reported by Weaver and Thompson (1982).

To date, no known study has considered differences in somatotype across discipline. Dancers were less endomorphic than free skaters, which was not surprising, since endomorphy is an aesthetic liability for dancers (Table 35). They are primarily judged on their ability to form aesthetically pleasing lines with their partners during technical lifts and intricate step sequences involving long edges and hold positions. Pair skaters were more mesomorphic than both dancers and free skaters, which may be related to the technical requirements of over-head lifts. Superior upper body strength is essential for female skaters to support their body weight while they are lifted, twisted and thrown by their partners. Surprisingly, pair skaters did not have greater corrected arm circumference compared to the other two disciplines (Table 35).

Menarche

Although the numbers within each age group were relatively small, the distribution of skaters who had attained menarche suggests that female figure skaters are later maturers. Both the probit (14.2 $\pm$0.5 years, 95% CI: 13.2 to 15.2) and retrospective (13.6 $\pm$1.3 years) estimates were later than those of a reference sample of American and European girls, which is about 13.0 $\pm$ 1.0 years (Malina, 1994). Recalled ages at menarche are based only on girls who attained menarche, which limits the generalizability of this type of data (Livson and McNiel, 1962). In this sample of skaters $\geq$ 16 years of age, one girl (16.5 years) had not yet attained menarche and only two were early maturers (age at menarche < 12.0) (Table 20). Since early maturing girls were underrepresented in this sample, it appears that early maturers may have been socialized away from figure skating, while later maturers may have been socialized towards participation in figure skating. Although parents, coaches and friends played fundamental roles in influencing skating participation, it is not clear, which of socializing agents are involved in figure skating attrition.

Comparisons of the present status quo and retrospective data for age at menarche with other samples of athletes in aesthetic sports are presented in Table 59. The status quo results of the present study indicated a slightly later median age at menarche than the retrospective estimate in the present study and previous samples of skaters (Brooks-Gunn et al., 1988; Ross et al., 1980; Ziegler et al., 1998) and ballet dancers (Gavrilovic, 1983; Gavrilovic and Tokin, 1983; Warren, 1980). It is important to note that previous studies on skaters included pre-menarcheal girls in their samples, which underestimates mean menarcheal age. Junior Olympic divers have earlier mean ages at menarche than retrospective estimates for figure skaters in this study.

More specialized and elite skaters were later maturing than free skaters and test skaters, respectively (Tables 22 and 39), and this is consistent with Ross et al. (1980) who found the mean age at menarche of elite skaters to be 14.0 $\pm$1.3. Elite skaters in the present sample attained menarche significantly later than test skaters (Table 32), and there were proportionately more late maturing elite skaters.

These results are consistent with the available data suggesting successful female athletes tend to be late maturing individuals (Malina, 1983; Ross et al., 1980; Weaver and Thompson, 1981). With some exceptions, smallness, leanness and linearity of build are characteristics associated with later maturation. These characteristics are suggested as beneficial for figure skating which requires balance and force to support or move the whole body mass (Harris, 1986; Niinimaa, 1982; Ross et al., 1980). Accordingly, later maturation may be particularly beneficial for dance and pair skating since these skaters rely on male partners to be lifted and/or thrown. Cross-disciplinary comparisons indicated that pair skaters were later maturing than both free skaters and dancers, and that there were proportionately more later maturing pair skaters than free skaters and dancers (Table 39).

Pre-menarcheal skaters were smaller and leaner than post-menarcheal skaters (Table 41). However, the pre-menarcheal skaters were shorter and lighter, and the post-menarcheal skaters were taller and heavier than the respective skaters in the sample of Weaver and Thompson (1981) (Tables 40 and 56). Later maturing skaters were lighter and leaner, and had relatively longer legs compared to early and/or average maturing skaters (Table 46) which is consistent with data for non-athletes (Malina and Bouchard, 1991). It is interesting to note that pair skaters, who were later maturing, had proportionately longer legs and were more ectomorphic than test skaters (Table 35). Pre-menarcheal skaters were more ectomorphic, and less endomorphic and mesomorphic than post-menarcheal skaters. Among pre-menarcheal skaters there was little variation in anthropometric variables by age. Pre-menarcheal skaters were less endomorphic and mesomorphic, and more ectomorphic than post-menarcheal skaters. In addition, average maturing post-menarcheal skaters were more endomorphic than late maturing skaters.

The accumulation of biological data of athletes in aesthetic sports supports the view of Malina (1998) on the selective success in sport of later maturing girls and/or selective drop-out of early maturing girls. The overall anthropometric, physique and maturity characteristics of figure skaters in the present study were generally similar to those of skaters in previous investigations (Brooks-Gunn et al., 1988; Comper 199; Gledhill and Jamnick, 1992; Ross et al., 1980; Weaver and Thompson, 1081; Ziegler et al., 1998), and to athletes in other aesthetic sports such as gymnastics (Casper et al., 1997; Claessens et al., 1992), ballet (Brooks-Gunn et al., 1988; Casper et al., 1997; Warren, 1980), and synchronized swimming (Brooks-Gunn et al., 1988; Casper et al., 1997).

Mother-daughter correlations for age at menarche ranged from 0.15 to 0.40 (Malina et al., 1994). The correlation in the present study (0.60) was higher, which suggests environmental covariation in the small sample of 28 mother-daughter pairs.

Psychological Characteristics

Psychological coping, physical self-perceptions, social physique anxiety, and eating disorder risk comprised the components of the figure skater's psychological profile in this study. This composite of variables reflects the overall psychological well-being of adolescent female athletes competing in a socially evaluative context. Since a petite physique presumably facilitates jumping and artistic impression, positive self-perceptions such as satisfaction with Appearance, Global Physical Self-Concept, and Self-Esteem; and low SPA, Body Dissatisfaction and Drive for Thinness were desirable psychological characteristics. Unfortunately, inadequate reliability coefficients for the Ways of Coping Checklist (WCC) did not permit use of this instrument in the multivariate analyses.

Mean scores for the PSDQ and EDI subscale items and mean SPA for the present sample of figure skaters and those from previous investigations are presented in Tables 23 to 25. The physical self-perceptions of skaters were generally higher than non-athletes. Mean scores for PSDQ subscale items were higher than those reported by athletes in water polo, track and field, basketball, soccer, cycling, swimming, baseball, rugby, netball, cricket, and aerobics (Marsh et al., 1997), and by 13 and 14 year old adolescent non-athletes (Marsh et al., 1994). The trends suggest that figure skaters have more positive physical self-perceptions. The mean PSDQ subscale scores for the present sample were generally similar to elite adolescent gymnasts (Crocker and Snyder, 1997), with the exception of Health, Self-Esteem and Sport Competence which were slightly lower in the figure skaters. Compared to elite Australian adolescent athletes in track and field, basketball, soccer, cycling, swimming, baseball, rugby, netball (Marsh et al., 1997), the figure skaters in the present study had similar mean scores for all PSDQ subscales except Coordination and Appearance, which were lower in the present sample, and Global Physical Self-Concept, which is higher (Table 23). Unfortunately, Marsh et al.(1997) did not report sport-specific subscale scores which limit the utility of the above comparisons.

Reporting means for collapsed sport groups is a limitation of many sport psychological instruments, including the SPAS (Crocker and Snyder, 1997; Martin and Mack, 1996; Martin et al., 1997; McAuley and Burman, 1993) and the PSDQ (Crocker and Snyder, 1997). This limits sport-specific comparisons. It is reasonable to assume that female athletes in team sports would have different physical self-perceptions and SPA compared to athletes in individual or aesthetic sports. Further, many investigations using sport psychological instrumentation did not control for age in adolescent samples which may bias the data.

SPA increased with age among figure skaters, which is consistent with previous research on cheerleaders (Reed and Gill, 1996). Means for the total sample of figure skaters were similar to a sample of adolescent female athletes in several sports including basketball, tennis, volleyball, gymnastics, diving, swimming, synchronized swimming, soccer and softball (Crocker and Snyder, 1997), and a sample of elite female soccer players and figure skaters (Martin et al., 1997). SPA in the present sample of figure skaters was higher than young elite gymnasts (Martin et al., 1997), but lower than a sample of older adolescent gymnasts (McAuley and Burman, 1993). A closer examination of means when skaters were grouped by ages that were similar to previous studies (Table 24) indicated that skaters' SPA scores were similar to each sample, with the exception of adolescent gymnasts who have higher means (McAuley and Burman, 1993).

Although a high SPA score (> 4.0) has been typically expected for athletes in aesthetic sports (Crocker and Snyder, 1997; Martin and Mack, 1996; Martin et al., 1997; McAuley and Burman, 1993), figure skaters generally did not report being concerned about presenting themselves in front of others as apparent in the samples of Martin et al.

(1997). However, an examination across figure skating disciplines indicated that there were differences by competency level. Test and elite skaters reported significantly higher SPA than pre-elite skaters (Tale 24).

Mean EDI subscale scores of figure skaters were generally lower than normative data for college women (Garner et al., 1982), weight restricters (Garner and Olmstead, 1984), and suggested adolescent norms (Rosen et al., 1988). With few exception, the figure skaters had scores that were similar to adult gymnasts and higher scores than adult runners (Warren et al., 1990) (Table 25). In the present study, skaters were also higher than adult gymnasts, swimmers and runners in Maturity Fears, which may be expected since many of the skaters were adolescents anticipating sexual maturation. For the total sample, the low Body Dissatisfaction and Drive for Thinness scores were encouraging because these scores suggest a lack of eating disorder risk in this sample of skaters. This is not consistent with previous research (Davis, 1994; Sykora et al., 1993; Taylor and Ste. Marie, 1998) reporting a high prevalence of eating disorder risk among female athletes in sports including gymnastics, track, rowing and figure skating. However, age-related trends suggest that skaters ≥17 years may be at risk based on their mean Body Dissatisfaction scores (Table 28), which were above the cut-off (≥10) for being classified as at risk for eating disorders (Garner and Olmstead, 1982).

As hypothesized, physical self-perceptions generally decreased with age, while SPA and eating disorder risk increased with age (Tables 29 and 36), suggesting physical changes typically associated with growth and maturation (increases in weight and subcutaneous fat) may negatively influence self-perceptions and social physique anxiety (Brooks-Gunn, 1988; Brooks-Gunn et al., 1985). Adolescence is accompanied by a heightened sense of physical awareness, which is incorporated into overall physical self-perceptions and self-esteem (Fox and Corbin, 1989; Marsh et al., 1997). Despite age-related trends, the psychological profile of the skaters suggests positive self-referent affect and cognitions. In addition to low SPA, the skaters reported favorable self-esteem and physical self-perceptions, and did not appear to be at risk for developing eating disorders. However, since the EDI is typically only a screening device for a tendency for eating disorders, it cannot be not assumed that the skaters were free of disordered eating behaviors.

The results of the present study were somewhat consistent with Martin et al. (1997), who suggested that the favorable psychological profile of elite figure skaters may be related to high levels of fitness, successful sport experiences, and later maturation among skaters which would limit the negative influences of weight gain associated with puberty. While Martin et al. (1997) found a positive relationship between estimated percentage body fat and SPA in elite skaters, maturity status and timing were not considered in the analysis. Variation in maturity status and timing, and level of competency as in the present study, provide some evidence for the assertions of Martin et al. (1997). Post-menarcheal skaters reported higher SPA than pre-menarcheal skaters, but there was no difference between average and late maturers in SPA. The influence of successful experience was also equivocal since there was no SPA difference between test and elite skaters. Although pre-elite skaters reported lower SPA than test and elite skaters, this may be a function of the pre-menarcheal status of the pre-elite skaters; 32 (67%) of the pre-elite skaters were pre-menarcheal, and pre-menarcheal skaters reported lower SPA than post-menarcheal skaters when controlling for age (Table 43).

Elite skaters had higher mean PSDQ subscale scores for Physical Activity and Endurance than both test and pre-elite skaters, whereas the pre-elite and elite skaters had a higher mean than test skaters in Appearance and Self-Esteem than test skaters (Table 31). However, post-menarcheal skaters reported lower Self-Esteem than pre-menarcheal (Table 43), and more specialized skaters (dancers) reported significantly lower mean PSDQ scores for Health, Coordination, Sport Competence and Strength than free skaters (Table 38).

Positive physical-self-perceptions appeared to characterize elite, specialized skaters, but what remains unclear is when these physical self-perceptions emerge. Although positive physical self-perceptions are a component of confidence in sport (Vealey, 1986) and may improve the likelihood of attaining success in skating, it may be that successful skating experiences enhance physical self-perceptions.

Like test skaters, elite skaters also reported higher levels of SPA than pre-elite skaters. Although there were no differences in mean EDI scores by level of competency, test and elite skaters $\geq$13 years were above the cut off ($\geq$10) in the EDI Body Dissatisfaction scores (Appendix F, Table 11). More elite skaters met the classification for both eating disorder risk criteria (Body Dissatisfaction, 43%; Drive for Thinness scores, 47%) compared to test (30% and 33%, respectively) and pre-elite skaters (27% and 20%, respectively), but the differences were not significant. This observation among elite skaters is somewhat unexpected since elite skaters were leaner, as indicated by significantly lower sum of 6 skinfolds and lower endomorphy. Female adult non-athletes (Hart et al., 1989) and female adolescent athletes (Crocker and Snyder, 1997; McAuley and Burman, 1993), who have a low estimated percentage body fat and/or perceptions of low body fat, do not report high SPA. However, whether such athletes are selected because they are lean, or whether leanness is an effect of training remains unclear.

One possible explanation for higher SPA and Body Dissatisfaction scores in elite and test skaters is the increasing stakes that are attached to higher levels of competition, which pre-elite skaters are just beginning to experience. Self-presentation becomes increasingly important as a distinguishing feature among elite skaters at higher levels of competition, who may be similar in physical ability. The similarity of test skaters and elite skaters might be related to the experiences of the former. Test skaters may represent former elite competitive skaters, who moved down to the test level, where average and perhaps early maturation are prevalent. Thus, some test skaters may have had similar high stakes attached to self-presentation in their competitive experiences as those who are currently elite competitors.

The perceptions of Coordination, Sport Competence and Strength of free and pair skaters were, on average, greater than dancers (Table 38). Free skaters also reported, on average, higher mean scores on perceptions of Health than dancers and pair skaters. It is not surprising that free and pair skaters had more favorable self-perceptions in these PSDQ subscales, since both disciplines require exceptional coordination and strength for executing jumps and spins. Although dancers, who were higher in the mean Bulimia scores, reported higher Interpersonal Distrust scores compared to free skaters and pair skaters, the values were well below these reported by female weight restricters (Table 28). Although the mean Body Dissatisfaction and Drive for Thinness scores for dancers and pair skaters in the present sample did not suggest that dancers and pair skaters were at greater risk for developing eating disorders, the proportion of dancers and pair skaters (combined) who met the eating disorder risk criteria (Body Dissatisfaction $\geq$10, Drive for Thinness $\geq$15) were 38% and 54%, respectively. These percentages are similar to the those of Taylor and Ste. Marie (1998), who found that 43% of a sample of dancers and pair skaters met the criteria for Drive for Thinness. In contrast, 60% of a sample of elite female gymnasts met both criteria (Petrie, 1993).

A closer examination of differences across age by discipline indicate that older ($\geq$15) dancers and pair skaters reported mean Body Dissatisfaction and Drive for Thinness scores (dancers only) close to, or above the cut-off for eating disorder risk classification. Similarly, 15-16 year old free skaters were also close (10.5 $\pm$ 7.3) to the cut-off for Drive for Thinness scores. The majority of skaters in this age group were post-menarcheal and probably experienced increases in weight and subcutaneous fat associated with sexual maturation. It is reasonable to assume that elevated Body Dissatisfaction and Drive for Thinness scores emerging in this group of skaters might be related to physical changes associated with normal growth and maturation. In a longitudinal study of body dissatisfaction in adolescent boys and girls at 13, 15 and 18 years of age, girls' body dissatisfaction increased while boys' decreased (Rosenblum and Lewis, 1999).

Age-related trends were generally consistent across level and discipline, suggesting that physical self-perceptions decrease, and SPA and EDI scores increase with age. It was hypothesized that that menarche would be related to these psychological characteristics since the changes in body form, distortions of body image and a desire to become thinner accompany sexual maturation (Attie and Brooks-Gunn, 1989; Rosen et al., 1988).

Means for the PSDQ and EDI subscales and SPA for pre- and post-menarcheal skaters suggest a healthy psychological profile in the total sample. For both pre- and post-menarcheal skaters, means for the PSDQ subscales were above available normative values, SPA is low, and means for the EDI subscales were generally below data for weight restricters and even below normative data. However, when the proportions of pre- and post-menarcheal skaters meeting the risk classification criteria were considered, it is clear that eating disorder risk was more common among post-menarcheal skaters. Of the skaters meeting the Body Dissatisfaction criteria, 97% were post-menarcheal and of those meeting the Body Dissatisfaction criteria, 93% were post-menarcheal.

Smaller pre-menarcheal skaters had more positive self-perceptions as indicated by mean Health, Body Fat, Sport Competence, Global Physical Self-Concept, Endurance and Self-Esteem scores (Table 43). Post-menarcheal skaters, who were heavier, taller, and had thicker skinfolds, were less satisfied with their body; post-menarcheal skaters reported, on average higher SPA, Drive for Thinness, and Introceptive Awareness. Since pre-menarcheal skaters 11.00 - 15.99 years did not show any age-related differences in any of the psychological scores (Table 45), these results suggest that menarche, and its associated weight gain, may be a critical factor in lowering physical self-perceptions and increasing SPA and eating disorder risk.

In a closer look at the timing of menarche among post-menarcheal skaters classified as average (age at menarche $\leq$ 14.00 years) and late (age at menarche $\geq$14 years) maturing, the only difference for the PSDQ subscales was for Physical Activity; average maturing skaters reported lower scores than late maturing skaters. Although there were no mean differences between average and late maturing skaters in EDI subscale scores (Table 47), 75% of the skaters meeting the Body Dissatisfaction criteria for eating disorder were average maturing skaters and 70% of those meeting the Drive for Thinness criteria were average maturing. This supports previous assertions that the timing of sexual maturation may affect the risk for developing eating disorders. Longitudinal studies have shown that early maturing girls report higher EAT scores (Brooks-Gunn et al., 1989; Graber et al., 1994). Gross and Duke (1983) recommend counseling youth and her parents about the physical changes that will take place and her possible reactions to them.

In contrast with the widespread belief that athletes in aesthetic sports are at greater risk for developing eating disorders, results of the present study did not support this notion when the total sample of skaters was considered. However, when the skaters were grouped by level of competence, skating discipline, maturational status and timing, it was possible to identify groups who may be at greater risk for developing eating disorders. The prevalence of eating disorder risk was greatest among average maturing post-menarcheal skaters participating in dance, or among skaters of elite status, suggesting that biological and environmental factors may be involved in the development of eating disorders. These results should be interpreted with caution since dieting behavior was not assessed.

Although late maturing skaters did not appear to be at risk for eating disorders in the present study, late maturers may be most susceptible once they become young adults (> 18 years) with the eventual increases in weight and subcutaneous fat (LW Rosen, 1999, personal communication). If late maturers realize the social and/or athletic advantage of their leanness and linearity, they may strive to restrict their diet to maintain their leanness, but as weight and fat gain become inevitable later in life, late maturers may then resort to more drastic measures such as bingeing and purging in an attempt to control these changes.

While some authors have pointed to methodological limitations of scoring the EDI (Schoemaker et al., 1994; Welch et al., 1988), another methodological limitation may involve the interpretation of the questions by elite, specialized athletes participating in an aesthetic sport. As noted by Ziegler et al. (1996, p. 585): "comparisons to standard reference populations are not appropriate for adolescent athletes". Those who perceive their sport participation as their priority in life may be inclined to respond to EDI questions in a similar manner to those who are at risk for eating disorder, or, perhaps underreport their responses. Thus, it may be inappropriate to impose eating disorder risk classifications developed for non-athletes, such as those for Body Dissatisfaction and Drive for Thinness, on elite athletes participating in aesthetic sports.

Psychological Correlates of Physical Characteristics

It is suggested that positive self-evaluations provide a competitive edge for elite athletes (Vealey, 1986). For females competing in subjectively evaluated sports, self-evaluations are affected by sociocultural ideals of feminine beauty, which tend to favor a lean petite physique (Attie and Brooks-Gunn, 1989; Casper and Simon, 1997; Hamilton et al., 1985; Nemeroff et al., 1994). Weight control and self-doubts about talent have been identified as sources of stress by elite figure skaters (Scanlan et al., 1989b; Gould et al., 1993b), suggesting that dissatisfaction with physical characteristics is a potential liability for achieving success in skating, among other factors. These negative self-evaluations and dissatisfaction with the physical self may interact to impact more global measures of self-concept (Crocker and Snyder, 1997; Marsh et al., 1997), and oftentimes these evaluations may involve distorted body images (Duncan, 1985; Johnson et al., 1995; Kolb, 1959; Van

Despite numerous assertions about relationships among physical characteristics and perceptions of these characteristics, few studies have considered relationships among measured physical variables and psychological constructs measuring perceptions of the physical self. The SPA literature claims construct validation through correlating the SPAS with the BMI and estimated percentage body fat, calculated from body density using standard age-specific equations (Hart et al., 1989; Martin et al., 1997). However, the relationship between social physique anxiety and a quantitative estimate of physique (somatotype), has not been previously considered in the SPA literature. One of the purposes of the present study was to examine the relationships among physical characteristics, including somatotype, and the perceptions of physical characteristics such as Appearance, Body Fat and Body Dissatisfaction.

The variables included in the correlational analyses were weight, stature, sitting height, the sitting height/stature ratio, estimated leg length, the sum of 6 skinfolds, and the three somatotype components. The psychological variables included Body Fat, Appearance, Global Physical Self-Concept, Self-Esteem, Body Dissatisfaction, Drive for Thinness, Maturity Fears, Perfectionism, Bulimia, and SPA. Chronological age was controlled and fourth-order partial correlations were used for the somatotype components.

The correlations among measured physical characteristics and the psychological subscales were in the expected direction, but were low to moderate (Table 48). There were significant negative, low to moderate correlations (-0.17 to -0.48) between height, weight, sum of 6 skinfolds, endomorphy, and psychological indicators including Body Fat, Global Physical Self-Concept, and Self-Esteem. The correlations between height, weight, the sum of skinfolds and the endomorphic component of somatotype, and SPA and Bulimia were positive and low to moderate (0.18 to 0.54). In contrast, the positive correlation between ectomorphy and Body Fat and Global Physical Self-Concept, and the negative relationships between ectomorphy and Body Dissatisfaction, Drive for Thinness, and SPA suggested that leaner skaters were more satisfied with their physical self.

When controlling for height and weight, variables that are positively correlated during adolescence (Malina and Bouchard, 1991), many of the correlations decreased with the exception of correlations with body weight when age and height were statistically controlled (Table 49). The significant low to moderate negative correlations (-0.20 to -0.44) between body weight and Body Fat, Global Physical Self-Concept and Self-Esteem suggested that heavier skaters reported negative self-perceptions. The low to moderate positive correlations between body weight and Body Dissatisfaction and SPA suggested that heavier skaters were less satisfied with their bodies and reported higher SPA. It is interesting to note that perceptions of Body Fat correlated significantly with each of the physical variables (height, weight, sum of 6 skinfolds) when height and weight were statistically controlled. Further, the correlation between height, with age and body weight held constant, was positive, suggesting that taller skaters had more favorable self-perceptions of Body Fat.

Body Dissatisfaction and Drive for Thinness affect the ability of the individual to differentiate between what is normal and underweight (Garner et al., 1982). Since the majority of skaters were below reference medians for body weight (Figure 4) and skinfold thicknesses (Figures 22 and 24), Body Dissatisfaction may be related to distorted body image (Duncan, 1985; Johnson et al., 1995; Nemeroff, et al., 1998; Van der Velde, 1985).

Further, the role of evaluating one's body in the social context inherent to figure skating probably intensifies this distortion leading to a heightened need to become thinner (Kolb, 1959).

Selection in Figure Skating

Competency Level

The general consensus in the talent identification literature is that an interdisciplinary focus is essential for the complex process of predicting athletic success (Bloom, 1985; Burwitz et al., 1994; Comper, 1991; Ericsson, et al., 1993). To date, researchers have not specifically compared recreational competitive skaters to their more elite peers. Research has been limited to identifying the physical and psychomotor characteristics of the elite prototypical skater (Comper, 1991; Faulkner, 1976; Gledhill and Jamnick, 1992). A primary purpose of this investigation was to examine the combined effect of physical and psychological variables thought to be important for the selection of successful figure skaters specializing in free, dance and pair skating. To this end, test or recreational competitive skaters were compared to more elite skaters identified as pre-elite and elite, who were pre-national and national level competitors.

Both biocultural (Malina and Bouchard, 1991) and contextual (Lerner, 1985, 1992) views emphasize the interaction between biological and psychological variables for healthy development through puberty. It appears that these interactions are also important in the identification and selection of specialized, elite athletes. Evidence suggests that certain physical characteristics related to body size and physique are important for success in figure skating (Gledhill and Jamnick, 1992; Ross et al., 1980; Weaver and Thompson, 1981). Although psychological variables discriminating successful athletes have been identified in wrestlers (Gould et al., 1981) and weightlifters (Mahoney, 1989), assessment of psychological variables important in figure skating selection and the interaction with physical characteristics has received little attention.

For the total sample of figure skaters, age and endomorphy correctly classified 58% of the skaters by competency level. Older skaters who were less endomorphic were more successful (Table 50). Among post-menarcheal skaters $\geq$15 years of age, age at menarche and Maturity Fears were included in the analysis in an attempt to tease out differences attributed to maturational timing. However, among the older skaters, only endomorphy, age, and Self-Esteem correctly classified 68% of the skaters by level of competency (Table 51). Older, less endomorphic skaters who had higher Self-Esteem were more successful. These results are consistent with Claessens et al. (in press) research on elite female gymnasts. Age and endomorphy were significant predictors of performance scores for the horse vault, uneven bars, beam, and floor; older, less endomorphic skaters were more successful. In the study of elite gymnasts, the contribution of age to the variance in performance scores ranged from 2.5 to 3.8%, while the contribution of endomorphy ranged from 26.9 to 35.7%. Other variables that contributed to the variance in gymnasts' performance scores were calf girth, sitting height, forearm girth, skeletal age, femur width, mesomorphy, and calf skinfold thickness.

The small set of discriminating variables in the present study might be explained by the reduced number of subjects considered in the analysis due to missing data. This also limited the number of variables in the analysis. However, as suggested in previous investigations, a low percentage of body fat (Comper, 1991; Faulkner, 1976; Gledhill and

Jamnick, 1992) and low endomorphy (Carter and Heath, 1990) are characteristic for elite levels of competition. If success is defined in the context of performance and followed over a season or at a competition, specific predictions may result. Including other psychological variables, such as sport confidence and competition anxiety, may also enhance the discrimination.

Discipline

The disproportionate ratio of male to female skaters is an additional concern for dance and pair skaters. Success in dance and pair skating depends in large part on both the physical and social compatibility of the couple. Lerner (1985) emphasizes the goodness of fit between individual characteristics and the demands of the context. Although the general context of figure skating involves strength, endurance, and aesthetic presentation, disciplinary specialization has additional physical and social demands. In pair skating, for example, a low center of gravity is necessary for landing throw-jumps, and upper body strength is necessary for supporting the body in overhead lifts. In contrast, dancers require relatively longer legs and a linear physique not only for intricate steps performed in close proximity to partners, but to accentuate body lines for aesthetic purposes and to match that of the partner. The social and psychological requirements of working with one's partner can superimpose on these physical requisites. It is reasonable to assume that positive physical self-perceptions are also important for disciplines involving presentations along side male partners.

In the present analysis, however, only age and endomorphy discriminated among free skaters, dancers and pair skaters, classifying about 66% of the skaters by disciplinary that discriminated discipline pre-elite and elite skaters also indicated that dance and pair skaters were older and less endomorphic than free skaters, correctly classifying 62% of the skaters. Endomorphy also classified 64% of post-menarcheal skaters $\geq$ 15 years; dance and pair skaters were less endomorphic than free skaters.

As a group, skaters who were less endomorphic were more specialized and successful, which likely reflects the selective nature of the sport. Apparently there is a preference in figure skating, especially in dance and pair skating disciplines, for lean, thin, non-fat skaters. It is not clear, however, who specifically is making the preferential decisions, coaches, judges, and /or figure skating organizations. Low endomorphy among the dance and pair skaters probably involves a variety of factors. Dance and pair skaters reported significantly more hours of practice than free skaters (Table 14) and thus, energy expenditure may, influence, in part, subcutaneous fatness and in turn, endomorphy estimates. However, diet, which also influences subcutaneous fatness and thus, endomorphy, is probably more important. This may be especially true for dance and pair skaters given the additional pressures to maintain a light, lean physique which facilitates lifting and throw jumping. Although assessment of dietary intake was not included in this study, Rucinski (1989) reported that elite skaters 17.6 years of age, consumed only 55% of the RDAs for energy. In contrast, a subsequent study showed that figure skaters (13.7 $\pm$ 1.7 years) consumed approximately 82% of the RDA for energy after adjusting for age and sex. However, it is important to note that RDA for energy intake may not reflect the energy needs for this select group of highly active adolescent athletes. It is also important to note that estimates of endomorphy ratings are influenced by quality of in the measurements of skinfold thicknesses, i.e., measurement variability.

Additionally, some evidence of eating disorder risk among figure skaters suggests that dance and pair skaters may be restricting their diet. Taylor and Ste. Marie (1998) showed that 43% of dance and pair skaters reported high EDI Drive for Thinness subscale scores. In the present study, older dance and pair skaters reported Body Dissatisfaction scores $\geq$ 10 (Table 36), suggesting that this group of skaters may be restricting their diet and may be at risk for disordered eating.

Self-Concept

It is generally assumed that a positive self-concept is essential for maintaining confidence in athletes (Vealey, 1986). This may be especially true for figure skating where success is contingent upon the skater's ability to artistically present herself in front of judges (Martin and Mack, 1996). Physical changes associated with growth and maturation during adolescence may be related to a negative self-concept, which can be a liability for aesthetic presentation and perhaps biomechanical efficiency in performing technical elements. Moreover, the wellness of young female athletes striving to maintain a petite, linear physique, which is apparently favored by judges, may be jeopardized as these youth may resort to restrictive eating and weight loss behaviors.

To investigate the well-being of adolescent competitive figure skaters, physical and psychological factors contributing to self-concept were considered. Self-concept is multifaceted and hierarchically organized (Shavelson, et al., 1976), and consistent relationships among self-esteem and body-esteem, and self-presentational concerns have been demonstrated (Crocker and Snyder, 1997; Martin et al., 1997). Social Physique Anxiety, Global Physical Self-Concept and Self-Esteem were used to characterize self-concept, which was predicted by a combination of physical and psychological variables in the present study (Table 53). Self-perceptions of skaters, as indicated in a bio-perceptual set of predictor variables, are linked to physical characteristics. More specifically, Appearance, Body Fat and Body Dissatisfaction entail perceptions of characteristics associated with physical appearance. With respect to this set of bio-perceptual variables, older skaters who were taller, heavier, less ectomorphic and less satisfied with their Appearance and Body Fat, and who had higher Body Dissatisfaction scores, had higher SPA and lower Global Physical Self-Concept and Self-Esteem (Figure 18). The data suggest that the physical characteristics identified as being integral to figure skating, such as low body weight and a linear physique (Gledhill and Jamnick, 1992), and skaters' perceptions of these characteristics contribute to their self-concept (Crocker and Snyder, 1997; Eklund and Crawford, 1994; Martin et al., 1997; Marsh et al., 1997).

Although some investigations have considered the relationship of objective physical variables with SPA scores (Eklund and Crawford, 1994; Hart et al., 1989; Martin et al., 1997), and the PSDQ (Marsh, 1993; 1996; Marsh and Roche, 1996), the present study is apparently the first to examine the relationship among somatotype, SPA and the PSDQ. Despite low SPA scores among skaters in the present study, the findings are consistent with previous research that found a relationship between SPA and body fat estimated from skinfolds (Eklund and Crawford, 1994), but contrast the findings of Martin et al. (1997), who observed no relationship between body composition estimated with densitometry and SPA in a combination of elite adolescent female soccer players, gymnasts, and skaters (13.3 $\pm$ 2.2 years). A fundamental limitation of presently available SPA data is the lack of sport-specific analyses.

Predictors of Eating Disorder Risk

Perceptions of the body predicted eating disorder risk, particularly in early (11-13 years) and mid- adolescence (14-16 years) (Brooks-Gunn et al., 1989; Graber et al., 1994). The gradual onset of puberty accompanied by many physical and physiological changes are unique to the individual in timing and tempo. But, when the onset of puberty occurs during critical periods of athletic selection, the likelihood of achieving success can diminish because of changes in size and body composition associated with puberty. For example, the growth spurt characterized by an increase in height and fat mass, may impede the coordination necessary for the timing of jumps and other technical elements involving aerial rotation, but there are also noticeable physical changes separating the maturing female from peers who may, or may not have experienced similar physical changes. Social comparisons associated with growth and maturation may increase the probability of developing unhealthy self-concepts and behavior problems during puberty (Brooks-Gunn et al., 1985; Silbereisen et al., 1989), particularly in subjectively evaluated sports.

Although the skaters in the present study did not report being at risk for developing eating disorders as indicated by EDI subscales scores, physical and psychological variables thought to predict eating disorder risk were considered in the analysis. After controlling for age, both physical and psychological variables predicted each EDI subscale, with the exception of Bulimia. All of the valences were in the expected directions. In general, taller and fatter skaters, who had negative self-perceptions of Health, Body Fat, and Appearance, and who had higher SPA, had higher EDI subscale scores (Table 54).

The primary physical predictors of the EDI subscales were height and/or endomorphy, but it is interesting to note that mesomorphy emerged as a predictor of Perfectionism. Given the vigorous self-discipline accompanying the pursuit of excellence in athletics or dance, it is not surprising that skaters who were perfectionists were more muscular (Mogul, 1980; Skowron and Friedlander, 1994). These skaters may have been more inclined to engage in weight lifting exercises in pursuit of a more 'perfect physique'.

The psychological variables that predicted EDI subscale scores included Health, Body Fat, Appearance, and Global Physical Self-Concept. The SPA score significantly and positively predicted each of the EDI subscales, accounting for 2 to 12% of the variance. SPA was the strongest predictor of Bulimia (12% of the variance). This is consistent with data for with female college students (Deihl, et al., 1998; Johnson et al., 1995). The observed relationships between SPA and EDI subscale scores suggested that anxiety about presenting oneself in front of others may negatively influence physical perceptions, eating behavior and social adjustment. It was also interesting that Body Fat was the strongest, negative predictor of both Drive for Thinness and Body Dissatisfaction, accounting for 34% and 47% of the variance, respectively (Table 54). The more endomorphic skaters reported higher Drive for Thinness and Maturity Fears, suggesting that fatter skaters perceived themselves as fatter than their peers. However, the results should be interpreted with caution since the skaters as a group were not generally endomorphic compared to somatotype data for non-athlete females (Table 58).

Overall, the results are consistent with previous studies of adolescents. Those who had low self-perceptions were more concerned with presenting themselves in front of others (Crocker and Snyder, 1997; McAuley and Burman, 1993) and reported higher eating disorder risk indicators (Duncan, 1985; Johnson et al., 1995; van der Velde, 1985).

CHAPTER VI

Summary

The purpose of this study was to examine physical and psychological characteristics, and their interrelationships, in a cross-sectional sample of 159 competitive female figure skaters11-22 years of age. Skaters from seven southern Ontario and four southern Michigan figure skating clubs representing test, pre-elite and elite ability levels and free, dance and pair skating disciplines participated in this study. The majority of the skaters were Caucasian, had an average of about 10 years of experience, practiced about 17 hours per week on, and off the ice and competed in approximately 10 competitions in the year prior to data collection.

Anthropometric variables included: height, weight, sitting height, limb circumferences, skeletal breadths, and skinfold thicknesses. The following variables were derived: the BMI, estimated leg length, sitting height/stature ratio, estimated mid-arm and calf muscle circumferences, sum of 6 skinfolds, trunk/extremity ratio and the Heath-Carter anthropometric somatotype. Menarcheal status was assessed with the status quo method (yes/no) and recall.

Psychological characteristics included self-concept, social physique anxiety, and eating disorder risk. Self-concept was assessed using the Physical Self-Description Questionnaire (PSDQ, Marsh, 1996), the Social Physique Anxiety Scale (SPAS, Hart et al., 1989) was used to assess anxiety felt when presenting oneself in front of others, and the Eating Disorder Inventory (EDI, Garner et al., 1983) was used to assess eating disorder risk. The Ways of Coping Checklist (WCC, Crocker, 1992) was administered to assess the coping skills of the skaters, but the data were discarded due to low reliability.

Figure skaters were, on average, below reference medians in most anthropometric variables. They were shorter, lighter, and leaner compared to United States reference data, and similar to athletes in other aesthetic movement forms. With respect to maturation, figure skaters were later maturing, on average, compared to non-athletes. The mean recalled age at menarche for skaters $\geq$ 16.0 was 13.6 $\pm$ 1.2 years and the median (probit) was 14.2 $\pm$ 0.5 years. Based on self-reported psychological characteristics, the skaters had positive self-perceptions, including high Self-Esteem and low Social Physique Anxiety, and did not appear to be at risk for developing eating disorders. However, a closer look at level, discipline, maturity status, and timing (average and late) indicated that a some skaters may be at higher risk than others.

Elite skaters were, on average, lighter, and had a lower BMI, shorter legs and sitting height than test skaters. They also had smaller limb circumferences and less subcutaneous fat, were less endomorphic and more ectomorphic, and were older at menarche than test skaters. Elite skaters also had more positive self-perceptions, but higher SPA than test skaters.

Physical and psychological characteristics also distinguished skaters across discipline. Free skaters were heavier and taller; had relatively shorter legs, larger limb circumferences, broader skeletal breadths, and thicker skinfolds; and were more endomorphic than more specialized skaters in dance and/or pairs. Free skaters also had positive perceptions of Coordination, Sport Competence, and Strength, and reported lower Bulimia and higher Interpersonal Distrust. Compared to pair skaters, dancers were taller, with relatively shorter leg length. Dancers also reported lower mean self-perception scores and SPA than test skaters. Pair skaters were lighter and shorter, had relatively long legs, narrow skeletal breadths, and the less subcutaneous fat than free skaters. Pair skaters were also less endomorphic and more mesomorphic than both free skaters and dancers, and had the latest mean age at menarche (14.5 $\pm$1.3 years) compared to the other two disciplines (free skaters, 13.4 $\pm$1.0 years; dancers, 13.4 $\pm$ 1.4 years). With respect to psychological characteristics, free and pair skaters reported, on average, more positive self-perceptions including the PSDQ subscales for Health, Coordination, Sport Competence and Strength, and lower EDI subscale scores including Bulimia and Interpersonal Distrust compared to dancers.

Pre-menarcheal skaters were smaller, leaner, less endomorphic and more ectomorphic than post-menarcheal skaters. They also had more positive psychological characteristics such as measured by the PSDQ subscales of Body Fat, Sport Competence, Global Physical Self-Concept, Self-Esteem and Strength than post-menarcheal skaters. In contrast, post-menarcheal skaters had higher EDI subscale scores for Body Dissatisfaction, Drive for Thinness and Introceptive Awareness, and a higher SPA score than pre-menarcheal skaters.

Late maturing (mean age at menarche 15.2 $\pm$ 0.7) post-menarcheal skaters $\geq$16 years of age were leaner and had narrower skeletal breadths, smaller limb circumferences and relatively longer legs than average maturing (mean age at menarche 13.1 $\pm$ 0.6) post-menarcheal skaters $\geq$16 years of age. Late maturing post-menarcheal skaters had more positive self-perceptions, including PSDQ subscales of Coordination, Endurance and Self-Esteem than average maturers. SPA and EDI subscale scores did not differ between average and late maturing skaters.

Correlation analyses indicated that all significant correlations between physical and psychological variables were low to moderate, and in the expected directions. This suggested that figure skaters' perceptions of physical characteristics were consistent with their physical dimensions. There were significant negative, low to moderate correlations (-0.17 to -0.48) between height, weight, sum of skinfolds, endomorphy, and psychological indicators including Body Fat, Global Physical Self-Concept, and Self-Esteem. The correlations between height, weight, the sum of skinfolds and the endomorphic component of somatotype, and SPA and Bulimia were positive and low to moderate (0.18 to 0.54). Heavier, fatter and more endomorphic skaters were more concerned with their physical appearance and about presenting themselves in front of others compared to those who were lighter, leaner and more ectomorphic. Lighter and leaner skaters also had higher Self-Esteem scores. The relationships between height and physique-related psychological characteristics were reduced when age and weight were statistically controlled, with the exception of Body Fat. Similarly, the relationships between the sum of skinfolds and physique-related variables were also reduced when age and weight were statistically controlled, with the exception of correlations with Body Fat. However, when controlling for age and height, most of the relationships between weight and physique-related characteristics remained significant.

Although physical and psychological characteristics identified elite and specialized skaters, only three variables correctly classified these skaters. Age and endomorphy discriminated across both level of competency and discipline in the total sample of skaters and in pre-elite and elite skaters. In contrast, among post-menarcheal skaters $\geq$15 years, age, endomorphy and Self-Esteem discriminated across level of competency, and age and endomorphy discriminated across discipline. More elite and specialized skaters (dancers and pair skaters) were generally older, less endomorphic and had higher Self-Esteem scores. When test skaters were removed from the analysis, endomorphy still discriminated free skaters and the more specialized dance and pair skaters; dance and pair skaters were more endomorphic than the free skaters.

A multivariate-multiple regression analysis was performed to predict self-concept from a combination of physical and psychological variables. A set of variables arbitrarily labeled "bio-perceptual" predicted the set of dependent variables characterizing self-concept. The combination of physical characteristics identified as being integral to figure skating included low body weight and a linear physique, and skaters' perceptions of Body Fat and Appearance, and their Drive for Thinness and Body Dissatisfaction scores contributed to their self-concept. A closer look at the correlations between the variables in the predictor set and those in the dependent set suggested that smaller and leaner skaters, who describe their specific physical attributes positively (i.e., are satisfied with Appearance and Body Fat), had positive self-concepts (i.e., high Global Physical Self-Concept and Self-Esteem, and low SPA scores).

Regression analyses were performed to determine if the susceptibility to eating disorders could be predicted by select physical an psychological characteristics. A combined effect of physical and psychological variables in the prediction of eating disorder risk accounted for 20% to 65% of the variance in selected EDI subscales (Bulimia, Drive for Thinness, Body Dissatisfaction, Maturity Fears, Perfectionism). When age was controlled, both physical and psychological variables predicted each EDI subscale, with the exception of Bulimia. Taller and fatter skaters, who had negative self-perceptions of

Health, Body Fat, and Appearance, and who had higher SPA, had higher EDI subscale scores.

Future Research and Recommendations

Progress towards elite status in figure skating requires a significant amount of time and financial commitment. While this investigation revealed distinguishing physical and psychological characteristics of more successful figure skaters in free skating, dance and pair skating, more research is necessary on this population of athletes before definite conclusions can be made. Once normal variation in growth and maturation across disciplines are identified, those involved in talent identification programs can attempt to select those skaters who may be best suited for each discipline.

While this investigation attempted to consider figure skating from an interdisciplinary perspective, inclusion of other variables that influence success in skating was beyond the scope of this study. The limited number of available skaters in dance and pair disciplines is a limiting factor. Examining psychomotor characteristics (i.e., jumping ability and aesthetic maneuvers) of skaters relative to body proportions, and body composition of male and female dance and pair skaters would be a valuable endeavor for future research because these may be additional variables of importance in refining talent.

Future investigations should also attempt to cross-validate the results of this study. More specifically, examining physical and psychological predictors of the EDI in a sample who report values indicative of eating problems would be valuable. Alternatively, the risk classification criteria of the EDI for athletes in aesthetic sports should be reconsidered. The present study would have benefited from examining the eating behaviors of the figure skaters to determine if the skaters, or those specializing in certain disciplines, have a tendency to restrict the diet.

Given the apparent relationships between physical and psychological variables among figure skaters across level of competency, discipline, maturational status and timing, four recommendations are offered. Sport governing bodies such as the CFSA and USFSA should (1) follow age-specific recommendations for training, (2) ensure that evaluation centers follow a conventional measurement protocol which enable comparisons with reference data for athletes and non-athletes, (3) caution parents, coaches, judges and officials about commenting on body weight-related characteristics, and (4) provide educational information to skaters, coaches, judges and parents regarding growth and maturation, psychological characteristics of athletes in aesthetic sports, and the implications of these interacting characteristics on the training, nutrition and wellbeing of female adolescent athletes.

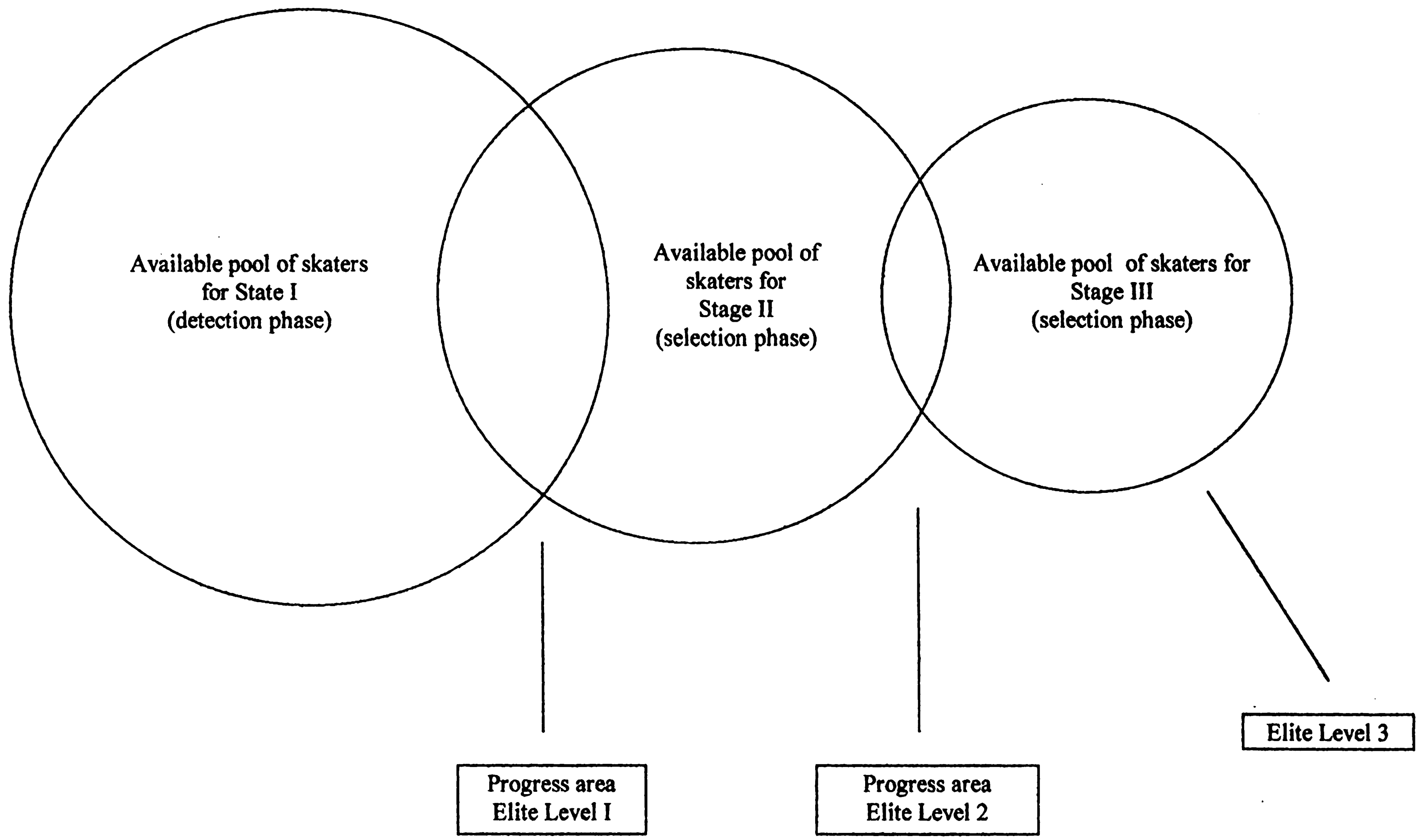
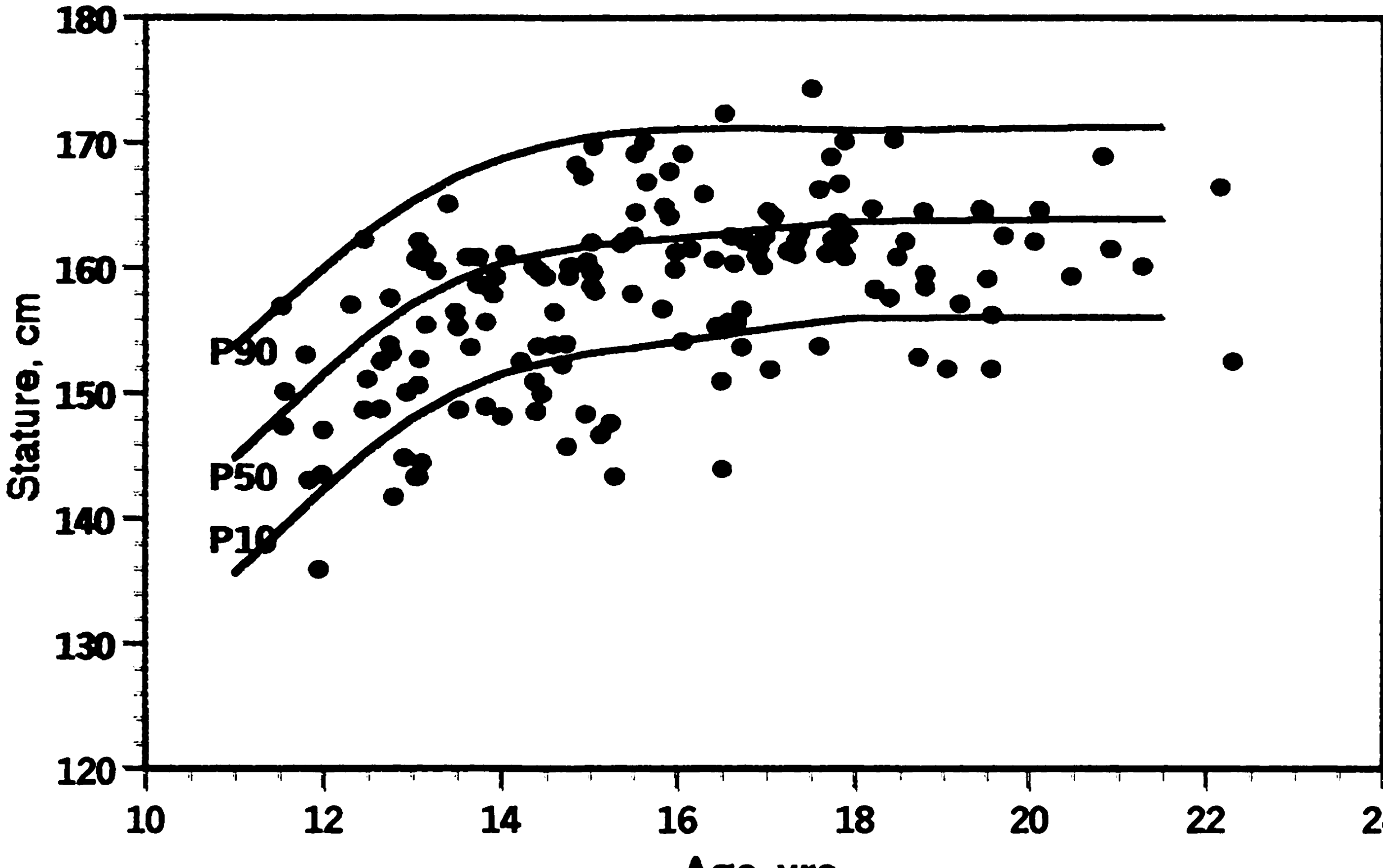


Figure 1. Stage model of talent identification in Canadian figure skating adapted from Comper (1991).



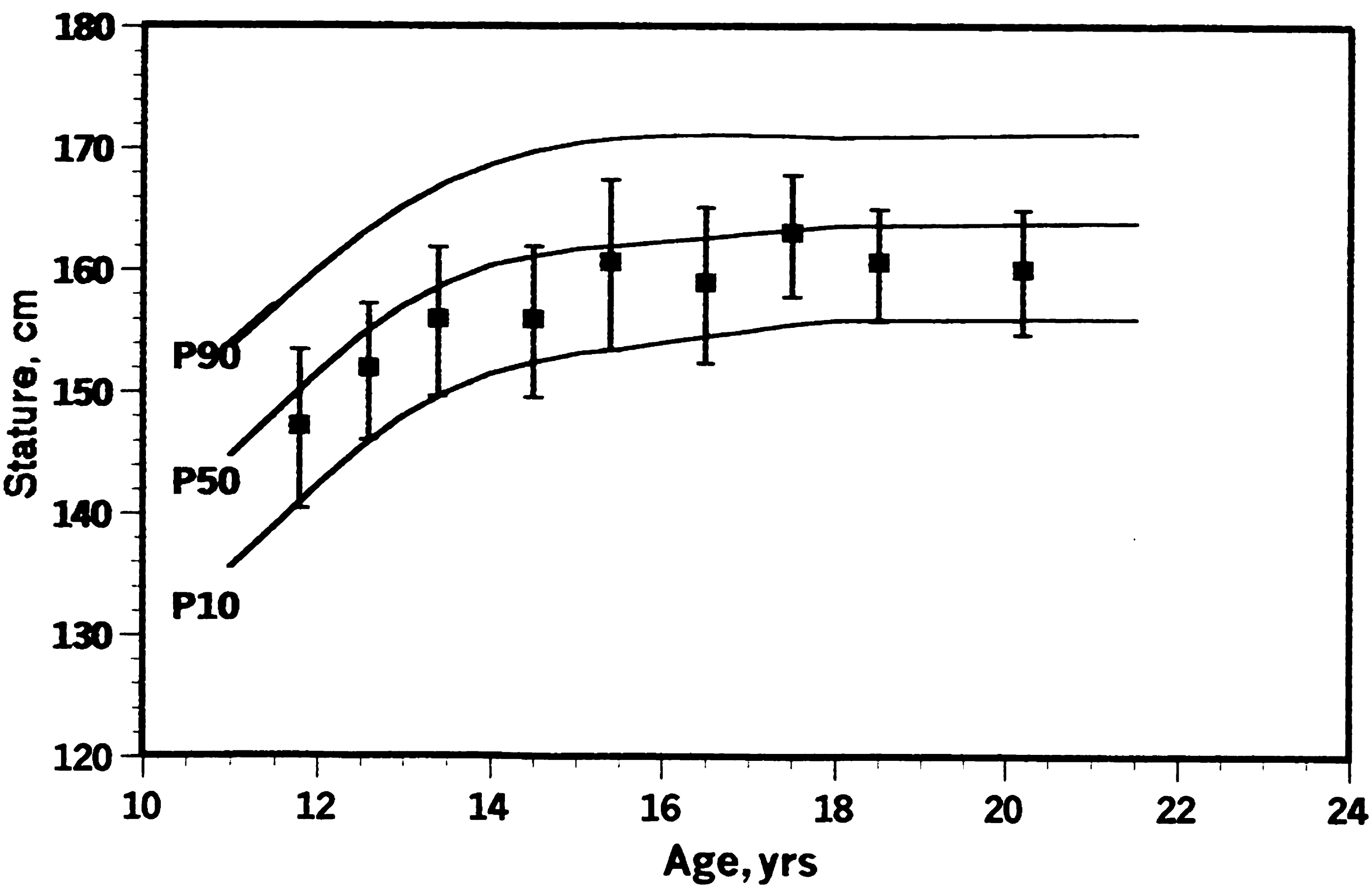


Figure 2. Statures of individual figure skaters (above) and mean statures (+ standard deviations) of figure skaters by whole year age groups (below) plotted relative to reference values for 11-18 years of age (Hamill et al., 1977; Najjar and Rowland, 1987).

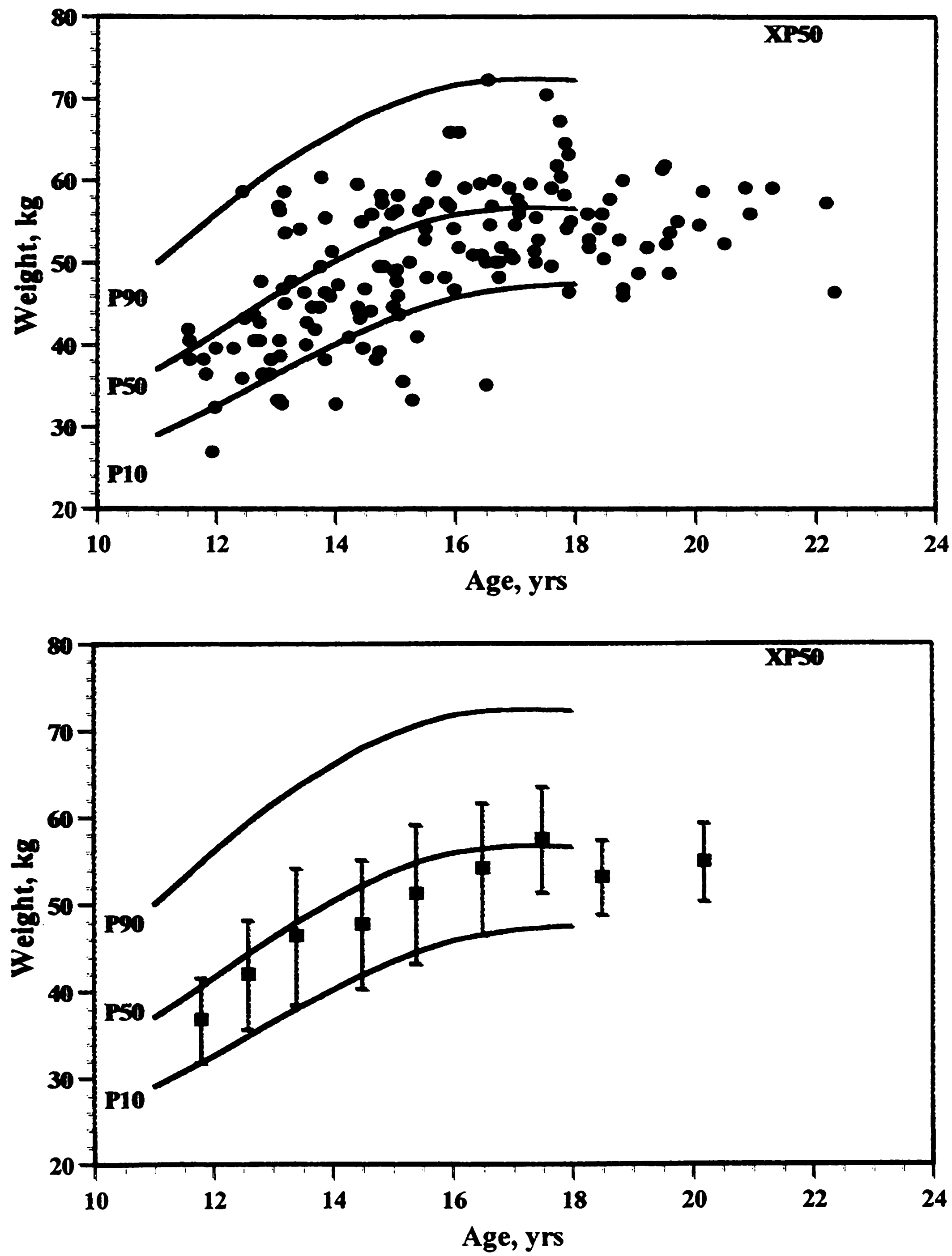


Figure 3. Weights of individual figure skaters (above) and mean weights (± standard deviations) of figure skaters by whole year age group (below) plotted relative to U.S. reference values for 11-18 years of age (Hamill et al., 1977). XP50 is the median for young adults 18-24 years of age (Najjar and Rowland, 1987).

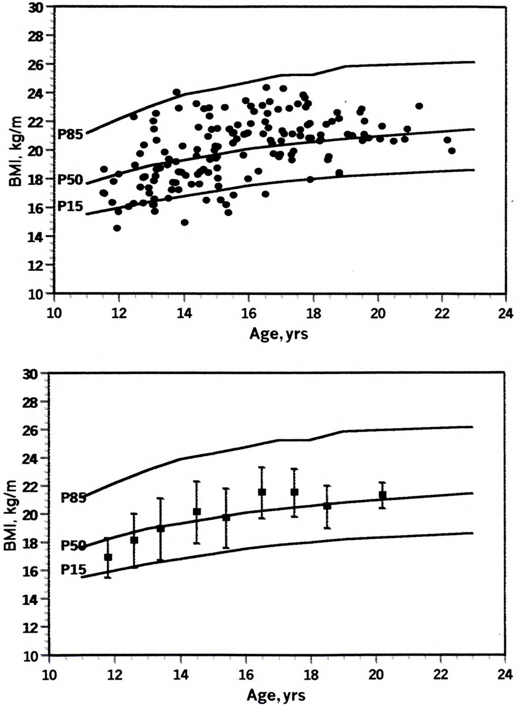
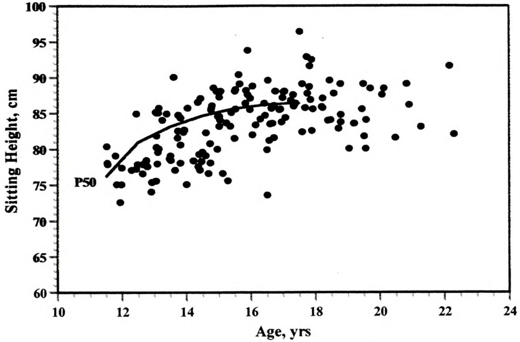


Figure 4. The body mass index (BMI) for individual figure skaters (above) and means (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Must et al., 1991).



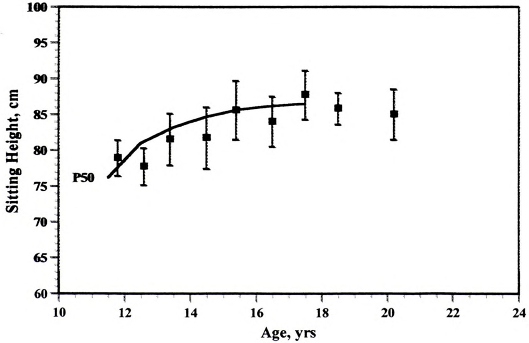
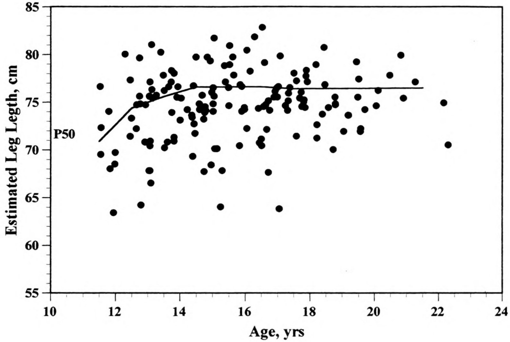


Figure 5. Sitting heights of individual figure skaters (above) and mean sitting heights (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values 11-18 years (Malina and Roche, 1983; Roche and Malina, 1983).



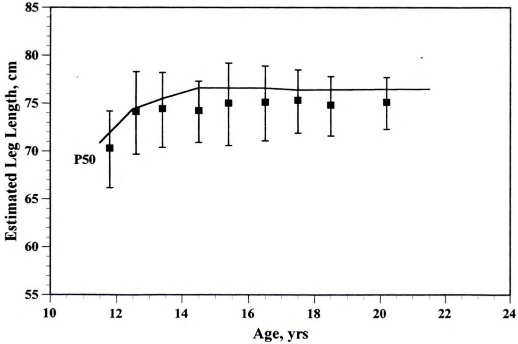
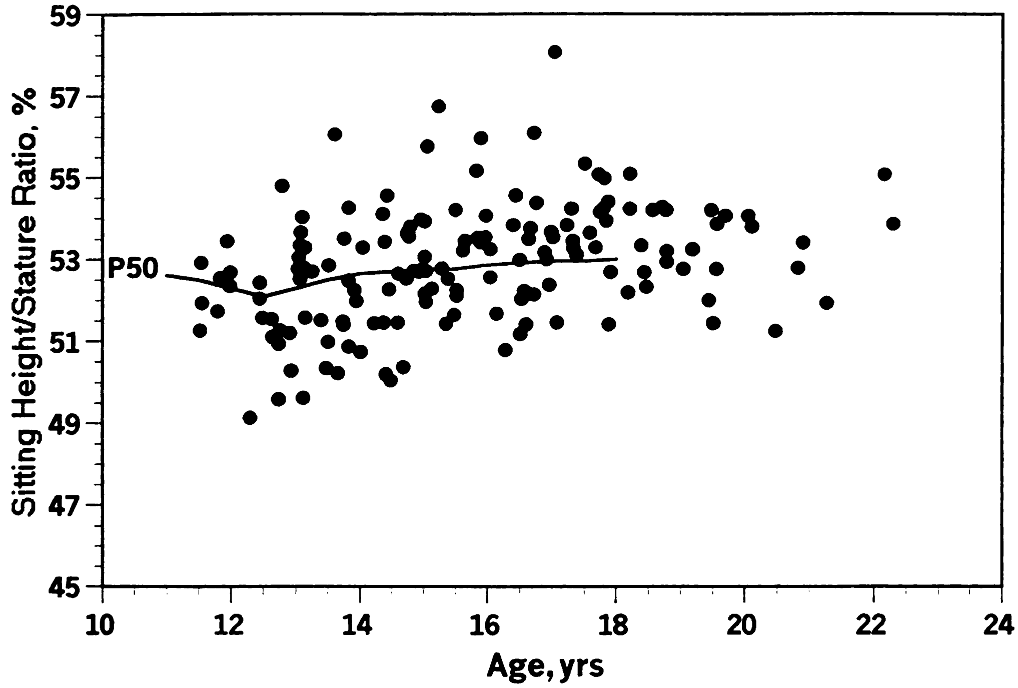


Figure 6. Estimated leg lengths of individual figure skaters (above) and mean estimated leg lengths (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Malina and Roche, 1983; Roche and Malina, 1983; Najjar and Rowland, 1987).



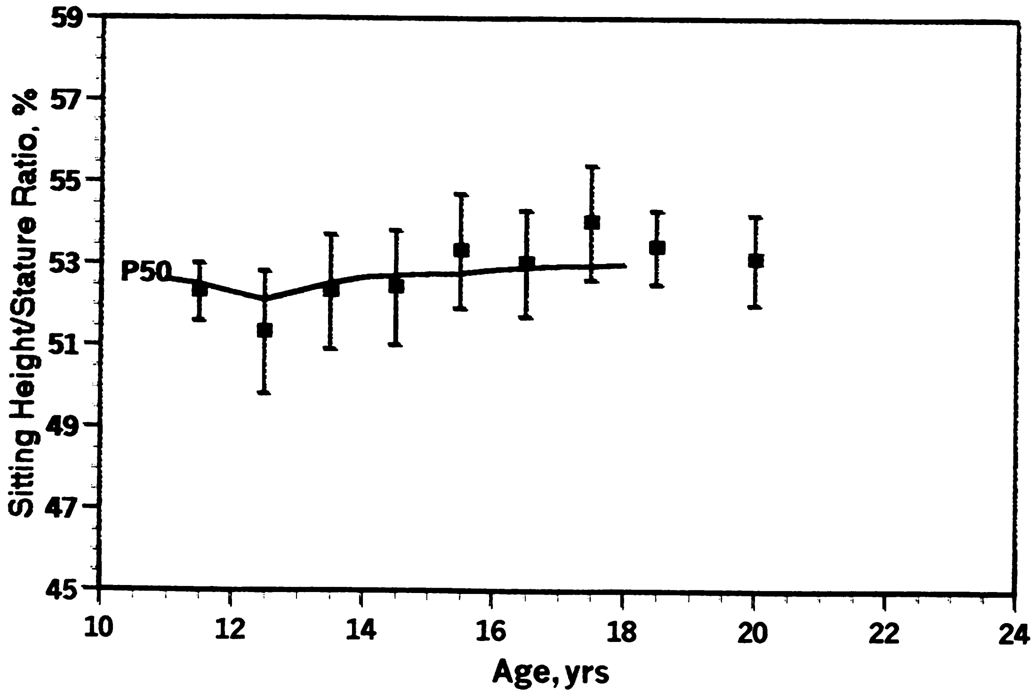
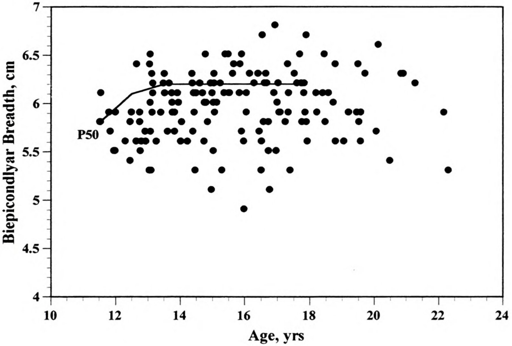


Figure 7. Sitting height/stature ratios of individual figure skaters (above) and mean sitting height/stature ratios ($\pm$ standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Malina and Roche, 1983; Roche and Malina, 1983).



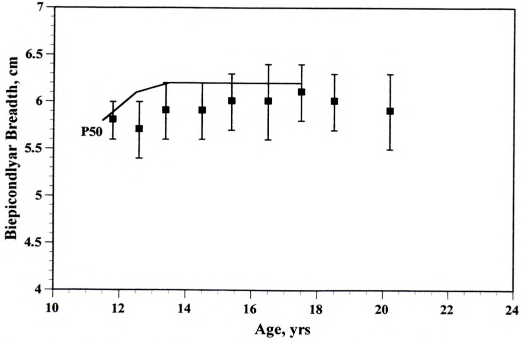
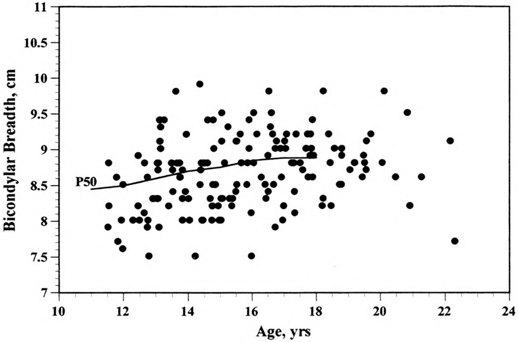


Figure 8. Biepicondylar breadths of individual figure skaters (above) and mean biepicondylar breadths (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Malina and Roche, 1983; Roche and Malina, 1983).



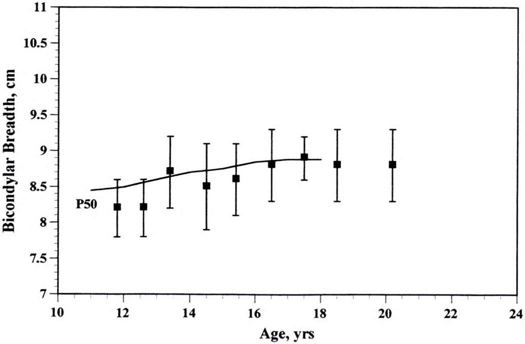
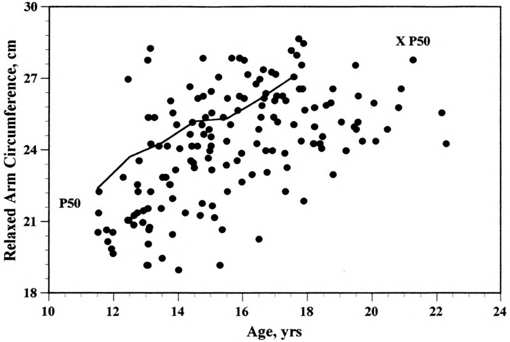


Figure 9. Bicondylar breadths of individual figure skaters (above) and mean bicondylar breadths (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Malina and Roche, 1983; Roche and Malina, 1983).



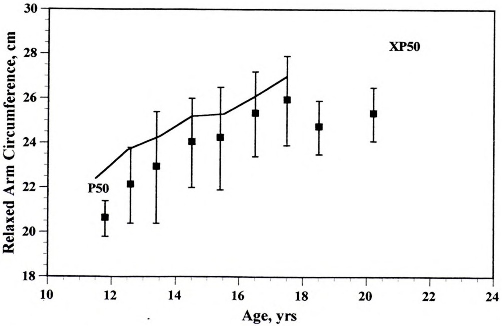
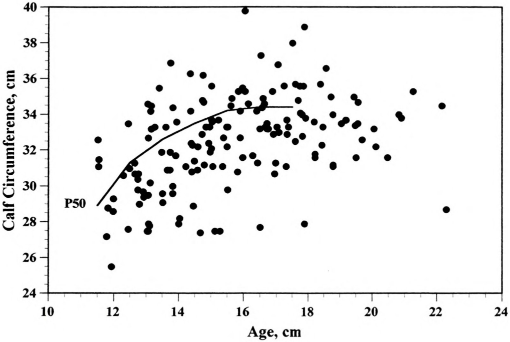


Figure 10. Relaxed arm circumferences of individual figure skaters (above) and mean relaxed arm circumferences (± standard deviations) of figure skaters by whole year age groups (below) plotted relative U.S. reference values for 11-18 years of age (Malina and Roche, 1983; Roche and Malina, 1983). XP50 is the median for adults 18-24 years (Najjar and Rowland, 1987).



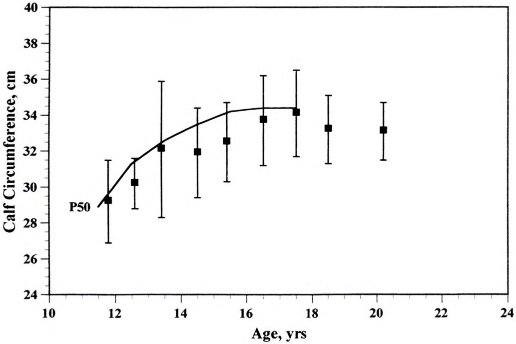


Figure 11. Calf circumferences of individual figure skaters (above) and mean calf circumference (± standard deviations) for figure skaters by whole year age groups (below) plotted relative to U.S. reference values (Malina and Roche, 1983; Roche and Malina, 1983).

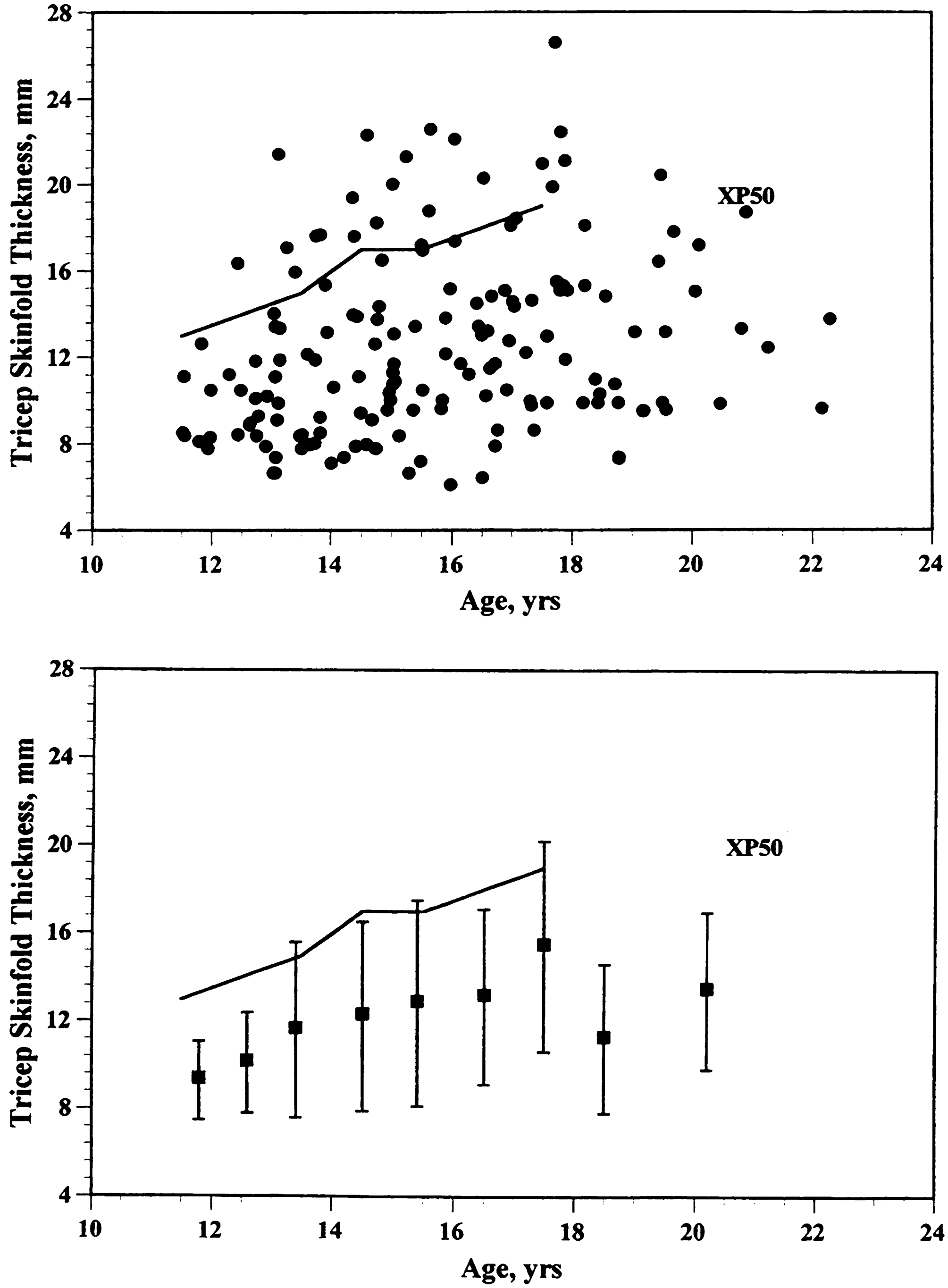


Figure 12. Triceps skinfold thicknesses of individual figure skaters (above) and mean triceps skinfold thicknesses (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values for 11-18 years of age (Johnston et al., 1974). XP50 is the mean for young adults 18-24 years (Najjar and Rowland, 1987).

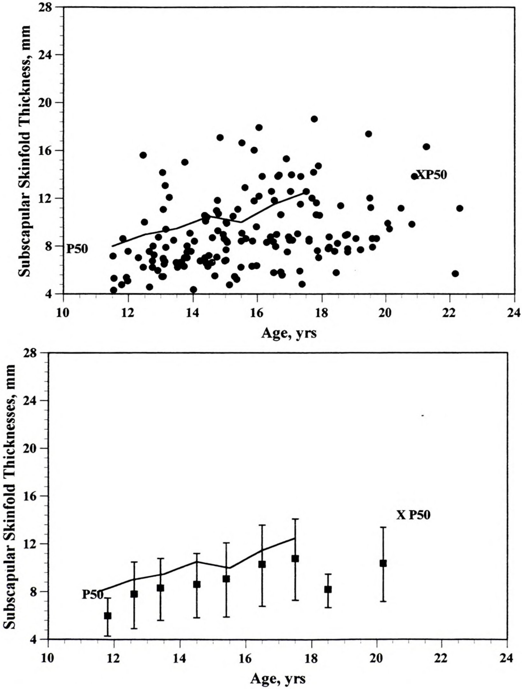


Figure 13. Subscapular skinfold thicknesses of individual figure skaters (above) and mean subscapular skinfold thicknesses (± standard deviations) of figure skaters by whole year age groups (below) plotted relative to U.S. reference values for 11-18 years (Johnston et al., 1974). XP50 is the mean for young adults 18-24 years (Najjar and Rowland, 1987).

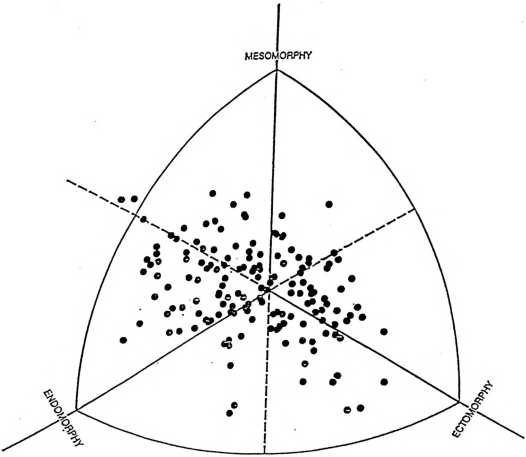


Figure 14. Somatotypes of individual figure skaters.

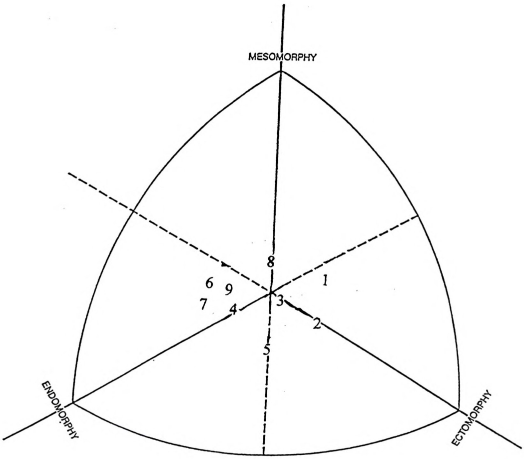


Figure 15. Mean somatotypes of figure skaters by age groups. 1 = 11.00-11.99; 2 = 12.00-12.99; 3 = 13.00-13.99; 4 = 14.00-14.99; 5 = 15.00-15.99; 6 = 16.00-16.99; 7 = 17.00-17.99; 8 = 18.00-18.99; 9 = 19+.

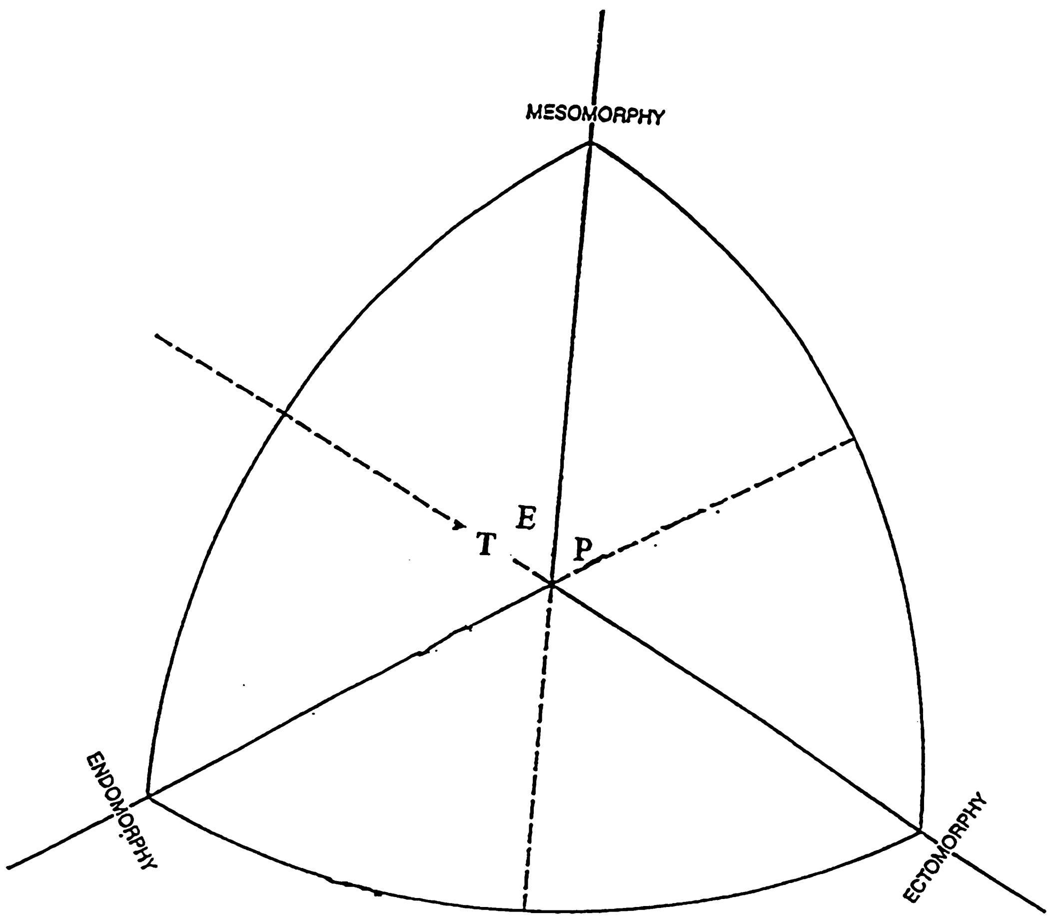


Figure 16. Mean somatotypes of figure skaters by level. T = test; P = pre-elite; E = elite.

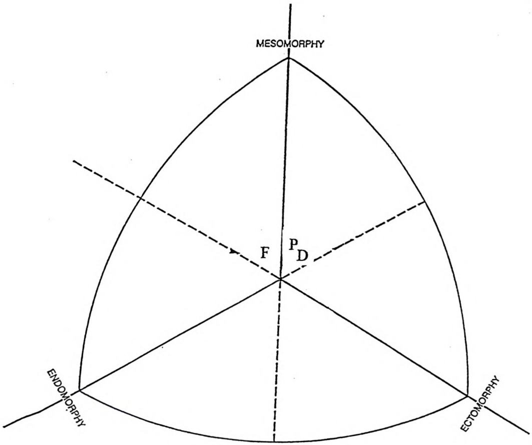


Figure 17. Mean somatotypes of figure skaters by discipline. F = free skaters; D = dancers; P = pair skaters.

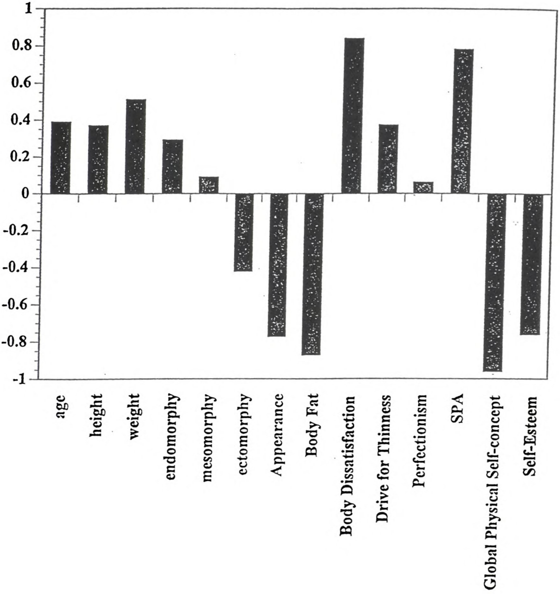


Figure 18. Correlations between the psychological variables comprising the self-concept canonical set and the physical and psychological variables comprising the bio-perceptual canonical set.

Table 1. Age, height, weight and BMI (when reported) of several samples of female figure skaters.

		Age, years		Height, cm		Weight, kg		BMI kg/m^2	
Sample, reference	n	M	SD	M	SD	M	SD	M	SD
Weaver and Thompson (1981)									
Pre-pubescent	6	13.1	1.2	147.9	9.6	39.0	7.3		
Ross et al. (1977b)									
Canada, novice	9	13.2	1.4	153.5	8.9	42.1	5.7		
Ziegler et al. (1998)									
Competitive	21	13.7	1.4	158.7	7.5	50.3	8.4	19.9	2.4
Faulkner (1976)									
Canada, > 12	21	14.0	1.7	154.1	8.5	45.5	8.2		
Comper (1991)									
Novice	28	14.5		157.6	7.4	48.1	7.6	19.5	3.1
Weaver and Thompson (1981)									
Post-pubescent	8	15.4	1.9	158.5	5.1	51.2	5.6		
Ross et al. (1977b)									
Canada, senior-junior	18	15.7	1.6	156.8	5.2	48.6	6.1		
Brooks-Gunn et al. (1988)									
Elite	25	14-18		160.7	6.0	48.2	5.6		

Table 2. Somatotypes of several samples of female figure skaters.

				Somatotype					
		Age		Endomorphy		Mesomorphy		Ectomorphy	
	n	M	SD	M	SD	M	SD	M	SD
Weaver and Thompson (1981)									
Pre-pubescent	6	13.1	1.2	1.8	0.5	2.8	0.9	3.3	1.0
Ross et al. (1977b)								i	
Canada, novice	9	13.2	1.4	2.1	0.4	3.7	0.7	3.9	0.7
Faulkner (1976)									
Canada, elite > 12	21	14.0	1.7	2.5	0.7	4.1	0.5	3.2	0.9
Weaver and Thompson (1981)									
Post-pubescent	8	15.4	1.9	2.4	0.4	3.4	0.6	2.8	0.6
Ross et al. (1977b)									
Canada, senior-junior	18	15.7	1.6	2.6	0.7	3.8	0.6	3.0	0.9

Table 3. Recalled ages at menarche in figure skaters and athletes in several other sports.

		Chronological Age		Mean Recalled Age at Menarche	
Sample, reference	n	M	SD	M	SD
Ziegler et al. (1998)					
skaters, competitive	21	13.7	1.4	12.4	1.2
Warren (1980)					
ballet dancers	15	13-19	15.4		
Brocks-Gunn et al. (1988)					
skaters	25	15.7	1.2	13.6	1.5
ballet dancers	64	15.6	1.3	13.3	1.3
swimmers	72	15.6	1.2	12.9	1.3
non-athletes	424	15.7	1.4	12.7	1.1
Ross et al. (1980)					
skaters, junior and senior	18			14.0	1.3
skiers, elite	9			12.9	0.9
secondary school	95			12.1	1.2
university women	31			12.1	1.1
Malina and Geithner (1993)					
Jr Olympic divers	28	17-19		14.1	1.3

Table 4. Results of two studies using the PSDQ with athletes in several sports and non-athletes.

	Crocker and Snyder (1997)	Marsh et al. (1997) A	B	C
Subscale				
n	114	757	349	720
Age, years	16.4	13.4	13.3	13.5
Health	5.0	4.7	4.9	4.8
Coordination	4.6	4.2	5.0	4.3
Physical Activity	5.5	4.1	5.1	4.2
Body Fat	4.8	4.6	5.2	4.0
Sport Competence	5.1	4.1	5.1	3.9
Global Phys. Self-Concept	4.9	4.5	5.1	3.9
Appearance	4.4	3.7	4.0	3.4
Strength	4.9	4.1	4.7	3.9
Endurance	4.6	3.5	4.6	4.3
Self-Esteem	5.3	4.7	4.7	3.5
Flexibility	4.5	4.1	5.7	4.4

Crocker and Snyder (1997), elite athletes (basketball, tennis, volleyball, gymnastics, diving, swimming, synchronized swimming, soccer and softball).
A- non-elite athletes (water polo, track and field, basketball,
soccer, cycling, swimming baseball, rugby, netball, cricket and aerobics).
B- elite athletes (track and field, basketball, soccer, cycling, swimming, baseball, rugby, netball).
C- high school students, non-athletes.

Table 5. Results of four studies of Social Physique Anxiety (SPA) in female athletes and non-athletes.

		Age		SPA	
Study	n	M	SD	M	SD
Martin et al. (1998)		13.3	2.2		
elite soccer players	24			2.7	0.7
elite gymnasts	9			1.8	0.5
elite skaters	35			2.5	0.7
McAuley and Burman (1993)[a]	236	14.4	1.8	3.4	0.5
Crocker and Snyder (1997)[b]	114	16.4	2.4	2.6	0.8
Hart et al. (1989)[c]	114	18.4	5.6	3.1	0.8

[a]Gymnasts.
[b]Basketball, tennis, gymnastics, volleyball, synchronized swimming, speed swimming, soccer, softball.
[c]Adult female non-athletes.

Table 6. Results of studies using the Eating Disorder Inventory (EDI) in samples of female athletes and non-athletes.

Subscale	Rosen et al. (1990)		Garner et al. (1982)		Garner and Olmstead (1984)	
	Female Adolescent Norms		College Women		Bulimic Anorexics	
	M	SD	M	SD	M	SD
n	747		137		38	
Age, years	14.6	3.5	20.3		20.2	
Body Dissatisfaction	11.3	7.7	9.7	8.1	15.5	7.8
Bulimia	2.1	3.3	1.7	3.1	8.1	6.3
Drive for Thinness	5.6	5.9	5:1	5.5	13.8	6.1
Ineffectiveness	4.2	5.1	2.3	3.8	12.1	8.6
Interpersonal Distrust	3.6	3.8	2.4	3.0	6.4	4.9
Intro. Awareness	4.5	5.3	2.3	3.6	11.4	7.0
Maturity Fears	4.2	3.6	2.2	2.5	5.6	5.8
Perfectionism	5.2	4.3	6.4	4.3	8.6	5.3

Subscale	Warren et al. (1990)				Skowron and Frielander (1994)	
	Runners		Gymnasts		Gymnasts	
	M	SD	M	SD	M	SD
n	12		15		55	
Age, years	19.3	1.6	19.3	1.6	19.4	1.1
Body Dissatisfaction	5.6	7.0	12.1	5.9	9.8	7.9
Bulimia	0.8	1.6	1.4	1.6	1.5	2.2
Drive for Thinness	2.9	3.1	8.4	5.9	5.4	5.7
Ineffectiveness	0.3	0.6	1.0	2.1	1.5	2.2
Interpersonal Distrust	1.4	2.1	5.3	2.2	2.2	2.7
Intro. Awareness	0.4	1.0	3.2	4.4	2.6	3.3
Maturity Fears	1.7	2.1	1.7	1.8	2.6	2.2
Perfectionism	4.9	3.0	7.3	5.3	6.8	3.8

Table 7. Sample size, ethnicity, and mean ages for the total sample and by level within discipline.

			Ethnicity			Age, years			
Discipline		Total	Caucasian	Black	Asian	M	SD	Min.	Max.
Free	Test	46	42	0	4	15.0	2.1	11.6	17.9
	Pre-elite	35	32	2	1	14.4	1.8	11.5	17.7
	Elite	26	23	0	3	17.1	2.2	14.4	19.6
	Total	107	97	2	8	15.3	2.3	11.5	19.6
Dance	Test	0	0	0	0	---	---	---	---
	Pre-elite	21	21	0	0	16.1	2.1	12.8	20.1
	Elite	8	8	0	0	18.7	2.8	15.0	22.3
	Total	29	29	0	0	16.8	2.5	12.8	22.3
Pairs	Test	0	0	0	0	---	---	---	---
	Pre-elite	10	10	0	0	13.6	0.8	12.3	15.0
	Elite	13	13	0	0	18.1	1.5	16.7	19.5
	Total	23	23	0	0	16.1	2.6	12.3	19.5
Total	Test	46	42	0	4	15.1	2.1	11.5	17.9
	Pre-elite	66	63	2	1	14.8	2.0	11.5	20.1
	Elite	47	44	0	3	17.7	2.2	14.4	22.3
Total		159	149	2	8	15.7	2.4	11.5	22.3

Table 8. Intra- and inter-observer technical errors of measurement for the present sample and previous research.

	Intra-observer TE				Inter-observer TE		
Study	1	2	3	4	1	3	4
n	15	13	22	77	13	9	224
Weight, kg	0.45				0.78		
Stature, cm	0.64	0.55	0.19	0.49	0.11	0.12	0.68
Sitting Height, cm	0.75		0.20	0.53	0.12	0.24	0.70
Breadths, cm							
Biepicondylar	0.16	0.07	0.04	0.11	0.14	0.12	0.24
Bicondylar	0.18	0.07	0.04	0.12	0.12	0.07	0.15
Circumferences, cm							
Arm, Relaxed	0.07	0.33	0.13	0.35	0.37	0.20	0.42
Arm, Flexed	0.16		0.17		0.08	0.24	
Thigh	0.35	0.36			0.12		
Calf	0.24	0.33	0.26	0.87	1.40	0.19	0.34
Skinfolds, mm							
Triceps	0.19	0.69	0.15	0.80	1.14	0.27	1.89
Biceps	0.13	0.24			2.03		
Subscapular	0.49	0.36	0.17	1.83	0.95	0.31	1.53
Supraspinale	0.46				4.69		
Abdominal	0.97				3.16		
Medial Calf	0.66	0.98	0.21	1.44	3.02	0.27	2.44
Endomorphy	0.01				0.28		
Mesomorphy	0.41				0.75		
Ectomorphy	0.07				0.28		

[1]Present study, North American competitive female figure skaters, 11.5- 22.3 years, within-day replicates.

[2]Meleski (1980) White age-group swimmers, both sexes, 8-18 years, replicates taken 1-4 weeks after initial measurements.

[3]Wellens (1989) White university students, 17-21 years, within-day replicates.

[4]Johnston et al. (1972) and Malina et al. (1973) U.S. Health Examination Survey, Cycle III, youth, 12-17 years, replicates taken within 2 ½ weeks after initial measurements.

Table 9. Psychological instrumentation subscale reliabilities and correlations with chronological age.

Variable	Chronbach α	r
WCC (n = 138)		
Active	0.68	
Problem Focused	0.74	
Social Support	0.63	
Reappraisal	0.76	
Wishful Thinking	0.55	
Self Contemplation	0.09	
Detachment	0.51	
Self Blame	0.73	
PSDQ (n = 128)		
Health	0.91	-0.26[b]
Coordination	0.84	-0.14
Physical Activity	0.88	0.20[a]
Body Fat	0.81	-0.31[c]
Sport Competence	0.92	-0.23[b]
Global Physical Self-Concept	0.90	-0.29[c]
Appearance	0.94	-0.06
Strength	0.83	-0.11
Endurance	0.90	0.02
Self-Esteem	0.83	-0.16
Flexibility	0.83	-0.06
EDI (n = 126)		
Body Dissatisfaction	0.94	0.42[c]
Bulimia	0.85	0.23[b]
Drive for Thinness	0.91	0.37[c]
Ineffectiveness	0.83	0.30[c]
Interpersonal Distrust	0.77	0.08
Introceptive Awareness	0.83	0.29[c]
Maturity Fears	0.70	-0.05
Perfectionism	0.73	0.11
SPAS (n = 135)		
SPA	0.91	0.30[c]

[a] $p < .05$; [b] $p < .01$; [c] $p < .001$.

Table 10. Completeness of data for the sample of figure skaters.

Variable	n	Frequency %
Anthropometric	159	100.0
Menarcheal Status	159	100.0
WCC	135	84.9
Demographic Information	133	83.6
SPAS	135	84.9
PSDQ	128	80.5
EDI	126	79.2
Parent Information	106	66.7
All data	93	58.5

Table 11. Years of experience in organized figure skating by age group.

Age Group	n	M	SD	Md	Min	Max
11 +	5	6.4	2.1	6.8	3.5	9.5
12 +	10	8.4	1.9	8.8	3.8	9.9
13 +	23	7.8	2.1	7.1	3.7	11.9
14 +	16	9.4	1.1	9.4	7.0	12.8
15 +	19	10.5	2.2	11.0	6.0	15.7
16 +	16	10.7	2.7	11.9	4.9	14.8
17 +	18	12.6	1.9	12.3	9.0	15.6
18 +	10	10.9	2.1	11.8	8.5	15.8
19 +	12	14.9	2.2	15.1	10.5	17.1
Total	129	10.2	3.0	9.8	3.5	17.1

Table 12. Sport and figure skating background for the total sample of figure skaters and partial correlations with level, controlling for age.

Variable	Total			Level
	n	M	SD	r
Skating experience, yrs	129	10.3	3.0	0.39*
Disciplinary experience, yrs	85	5.3	3.1	0.17
Age at first organized sport, yrs	117	4.9	1.9	-0.15
Age at first organized skating participation, yrs	129	5.4	2.1	-0.15
Age at skating specialization, yrs	130	8.7	2.4	-0.07
Age at first competition, yrs	127	8.7	2.4	-0.28*
Competitions in 1997, n	121	10.1	3.1	0.24*
Competitions in 1998, n	113	5.4	2.9	0.17
On-ice training hours/week	131	5.7	3.0	0.35*
Off-ice training hours/week	132	11.7	6.0	0.38*

* $p < .05$.

Table 13. Results of the ANOVA comparing sport and figure skating background information for the total sample of figure skaters by level.

Variable			Level								
			1. Test			2. Pre-elite			3. Elite		
	df	F	n	M	SD	n	M	SD	n	M	SD
Skating experience, yrs	2, 93	1.5	36	9.4[b]	2.8	57	9.4[c]	2.6	36	12.5	2.7
Disciplinary experience, yrs	2, 128	1.5	16	5.4[b]	2.6	43	4.7	2.6	26	6.3	3.8
Age at first organized sport, yrs	2, 129	0.2	36	5.1	1.9	50	5.1	2.0	31	4.4	1.9
Age at first organized skating, yrs	2, 126	5.2*	36	6.0	2.3	57	5.4	1.8	36	5.1	2.2
Age at skating specialization, yrs	2, 128	17.2*	38	8.9	2.4	57	8.7	2.4	35	8.5	2.4
Age at first skating competition, yrs	2, 124	3.7*	38	9.2[ab]	2.1	57	8.1	1.9	32	7.7	1.8
Competitions in 1997, n	2, 112	6.0*	38	9.8[ab]	2.6	49	9.9	3.0	34	11.1	3.8
Competitions in 1998, n	2, 118	5.6*	36	4.3[a]	2.7	47	6.3	2.2	30	5.2	2.9
On-ice training hours/week	2, 131	11.2*	36	4.4[ab]	2.8	58	6.4	2.9	37	6.2	3.1
Off-ice training hours/week	2, 132	11.3*	38	8.1[ab]	4.1	57	12.8	5.3	37	13.9	7.1

*p < .05.

[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 14. Results of the ANOVA comparing sport and figure skating background information of the total sample of figure skaters by discipline.

			Discipline								
Variable			1. Free			2. Dance			3. Pairs		
	df	F	n	M	SD	n	M	SD	n	M	SD
Skating experience, yrs	2, 94	0.8	69	5.1[b]	1.7	26	4.8[c]	1.6	22	4.6	2.7
Disciplinary experience, yrs	2, 128	2.3	86	5.7[b]	2.1	24	5.5	2.1	19	4.5	2.1
Age at first organized sport, yrs	2, 129	0.9	86	8.6	2.3	24	7.7	2.1	20	8.1	2.1
Age at first organized skating, yrs	2, 126	0.2	88	8.6	2.1	22	7.9	2.5	17	7.7	1.9
Age at skating specialization, yrs	2, 128	4.8*	86	9.7	2.8	24	11.1	3.1	19	11.7	3.0
Age at first skating competition, yrs	2, 124	15.4*	49	6.3[ab]	2.9	20	4.5	3.1	16	3.5	2.5
Competitions in 1997, n	2, 112	1.4	86	6.7[ab]	2.8	16	5.9	1.6	19	6.8	2.3
Competitions in 1998, n	2, 131	5.0	80	5.1[a]	2.9	14	5.5	2.4	19	7.2	3.7
On-ice training hours/week	2, 130	15.2*	87	5.3[ab]	4.2	24	13.5	7.9	20	14.6	8.3
Off-ice training hours/week	2, 132	2.6	88	9.9[ab]	3.0	24	3.7	2.7	20	6.3	4.6

* $p < .05$.

[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 15. Proportion (%) of skaters by level and discipline reporting those who influenced their skating participation.

	Level			Discipline			
Variable	Test	Pre-elite	Elite	Free	Dance	Pairs	Total
n	37	59	37	89	24	20	132
Mother	70	79	86	77	79	85	78
Father	43	41	56	46	34	60	46
Coach	24	20	21	23	20	15	21
Friend	27	22	21	24	20	20	23
Other	32	37	37	32	47	40	36

Table 16. Birth order of figure skaters by family size (top) and educational background of the parents of figure skaters (bottom).

	Family Size					
Birth Order	1	2	3	4	5	Total
1	15	31	5	2	1	54
2	0	32	10	2	0	44
3	0	0	10	1	0	11
4	0	0	0	2	0	2
Total	15	63	25	7	1	111

Education	N	%
Mother (n = 105)		
High school	27	26
Special skills training	17	16
Undergraduate degree	42	40
Graduate degree	19	18
Father (n = 99)		
High school	13	13
Special skills training	18	18
Undergraduate degree	37	37
Graduate degree	31	31

Table 17. Descriptive statistics for reported parental height and weight, and recalled age at menarche of mothers.

Level	Test			Pre-elite			Elite			Total		
Variable	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Father												
Stature, cm	29	177.2	7.3	39	176.6	5.4	29	177.0	5.4	97	176.9	6.2
Weight, kg	27	80.1	10.5	36	78.2	10.4	26	82.3	10.7	89	80.0	10.5
Mother												
Stature, cm	31	164.5	7.1	42	161.6	6.2	31	163.7	5.4	104	163.1	6.3
Weight, kg	37	62.2	8.6	39	59.2	8.6	18	60.7	10.2	94	60.7	9.1
Menarche, yrs	73	13.1	1.2	24	13.5	1.2	15	13.7	1.3	112	13.4	1.2

Discipline	Free			Dance			Pairs		
Variable	n	M	SD	n	M	SD	n	M	SD
Father									
Stature, cm	66	177.5	6.2	18	176.6	4.7	13	176.9	6.1
Weight, kg	61	80.4	9.6	16	77.7	8.7	12	79.9	10.5
Mother									
Stature, cm	69	163.9	6.3	20	161.2	6.7	15	163.1	6.3
Weight, kg	63	61.4	10.4	17	56.9	9.6	14	60.7	10.2
Menarche, yrs	69	13.2	1.1	26	13.6	1.7	17	14.0	1.3

Table 18. Anthropometric characteristics and correlations with age for the total sample of figure skaters (n = 159).

Variable	M	SD	Median	Min	Max	r
Age, yrs	15.7	2.4		11.5	22.3	
Weight, kg	50.0	8.6	66.3	26.8	72.1	0.54[c]
Stature, cm	157.8	7.0		135.8	174.2	0.45[c]
BMI, kg/m^2	20.0	2.5	21.7	14.5	24.3	0.45[c]
Sitting Height, cm	83.4	4.7		72.5	96.3	0.54[c]
SH/ST ratio, %	52.8	1.4		49.0	58.0	0.54[c]
Est. leg length, cm	74.4	3.7		63.3	82.7	0.20[a]
Breadths, cm						
Bicondylar	8.7	0.5		7.5	9.9	0.27[b]
Biepicondylar	6.0	0.4		4.9	6.8	0.15
Circumferences, cm						
Arm, relaxed	24.1	2.4		18.9	28.8	0.50[c]
Arm, flexed	25.4	2.4		20.8	30.0	0.51[c]
Calf	32.5	2.8		25.4	45.2	0.36[b]
Thigh	50.9	4.9		39.8	60.6	0.56[c]
EAMC, cm	21.4	1.6		15.9	26.8	0.33[b]
ECMC, cm	30.5	2.5		22.3	44.1	0.22[b]
Skinfolds, mm						
Triceps	12.5	4.2	11.6	6.0	26.5	0.24[b]
Biceps	5.4	1.9	5.1	2.3	11.3	0.01
Subscapular	9.0	3.1	8.3	4.2	18.5	0.29
Supraspinale	9.1	4.1	8.3	3.3	24.5	0.11[c]
Abdominal	10.7	4.9	9.2	3.9	30.1	0.12
Medial Calf	12.5	4.4	11.7	5.2	34.1	0.15
Sum of Skinfolds, mm	59.2	19.9	56.2	29.5	124.1	0.19[a]
T/E Ratio, mm/mm	0.95	0.22	0.91	0.51	1.76	0.07

[a] $p < .05$; [b] $p < .01$; [c] $p < .05$.

Table 19. Descriptive statistics for somatotype by age group.

		Somatotype					
Age Group	n	Endomorphy	SD	Mesomorphy	SD	Ectomorphy	SD
11+	8	2.5	0.6	3.6	0.6	3.9	0.8
12+	12	2.9	0.8	3.4	0.7	3.5	1.1
13+	23	3.1	1.0	3.7	0.8	3.3	1.0
14+	22	3.4	1.0	3.7	0.9	2.9	1.2
15+	25	3.2	0.1	3.3	1.0	3.2	0.1
16+	21	3.7	1.2	3.9	1.0	2.2	0.9
17+	20	3.9	1.0	3.7	0.8	2.4	0.7
18+	10	2.7	0.6	3.7	0.8	2.7	0.9
≥19	15	3.5	1.0	3.8	0.7	2.3	0.5
Total	159	3.3	1.0	3.7	0.8	2.9	1.0

Table 20. Menarcheal status of the total sample of skaters (n = 159) by age group and estimated median age at menarche via probit analysis (top), and distribution of recalled ages at menarche of post-menarcheal skaters $\geq$ 16.0 years (n = 67, 18.1 $\pm$ 1.5 years) (bottom).

		Age, years		Menarcheal Status		
Age Group	n	Mean	SD	No	Yes	% Yes
11 +	8	11.8	0.2	8	0	0.00
12 +	12	12.6	0.2	11	1	8.33
13 +	26	13.4	0.3	16	10	38.46
14 +	22	14.5	0.3	8	14	63.64
15 +	23	15.4	0.3	4	19	82.61
16 +	20	16.5	0.3	1	19	94.74
17 +	20	17.5	0.3	0	20	100.00
18 +	11	18.5	0.2	0	11	
19 +	17	20.2	1.0	0	17	
Median	SE	95% CI				
14.2	0.5	13.2 - 15.2				

	Frequency
Age Range	
10.00-10.99	1
11.00-11.99	1
12.00-12.99	17
13.00-13.99	26
14.00-14.99	11
15.00-15.99	7
16.00-16.99	4
M $\pm$ SD, years	13.6 $\pm$ 1.2

Table 21. Distribution, means, and standard deviations, and the mother-daughter correlation for recalled ages at menarche in post-menarcheal figure skaters $\geq$16 and their mothers (n = 28 pairs).

	Skaters	Mothers
Age Range		
11.00-11.99	1	2
12.00-12.99	8	3
13.00-13.99	11	12
14.00-14.99	5	7
15.00-15.99	1	3
16.00-16.99	2	1
M $\pm$ SD, years	13.5 $\pm$ 1.2	13.8 $\pm$ 1.2
r	0.60 ($p < .05$)	

Table 22. Means, standard deviations and correlations with age for the subscales of the Physical Self Description Questionnaire (PSDQ), Eating Disorder Inventory (EDI), and Social Physique Anxiety Scale (SPAS) for the total sample of figure skaters.

	PSDQ				EDI			SPA		
Subscale	M	SD	r	Subscale	M	SD	r	M	SD	r
1	4.7	0.9	-0.26[b]	1	2.7	3.9	0.23[b]	2.7	0.7	0.33[a]
2	4.7	0.8	0.14	2	5.9	4.0	-0.05			
3	5.0	0.9	0.20[a]	3	1.7	3.5	0.37[c]			
4	4.7	1.3	-0.31[c]	4	3.0	3.0	0.11			
5	4.7	0.9	-0.23[b]	5	3.5	2.5	0.08			
6	4.6	1.1	0.29[c]	6	5.2	4.0	0.29[c]			
7	4.5	0.9	-0.06	7	6.9	7.4	0.30[c]			
8	4.6	0.8	-0.11	8	4.9	6.0	0.42[c]			
9	9.0	1.0	0.02							
10	5.3	0.6	-0.16							
11	4.7	1.0	-0.06							

PSDQ: 1 = Health, 2 = Coordination, 3 = Physical Activity, 4 = Body Fat, 5 = Sport Competence, 6 = Global Physical Self-concept, 7 = Appearance, 8 = Strength, 9 = Endurance, 10 = Self Esteem, 11 = Flexibility.
EDI: 1 = Introceptive Awareness, 2 = Perfectionism, 3 = Bulimia, 4 = Interpersonal Distrust.6 = Maturity Fears, 7 = Body Dissatisfaction, 8 = Drive for Thinness.

Table 23. Mean PSDQ subscale scores in the present study and in previous research on athletes and non-athletes.

Subscale	Crocker and Snyder (1977)[1]	Marsh et al. (1997)[2]			Present Study
		A	B	C	
n	114	757	349	720	128
Age	16.4	13.4	13.3	13.5	15.8
Health	5.0	4.7	4.9	4.8	4.7
Coordination	4.6	4.2	5.0	4.3	4.7
Physical Activity	5.5	4.1	5.1	4.2	5.0
Body Fat	4.8	4.6	5.2	4.0	4.7
Sport Competence	5.1	4.1	5.1	3.9	4.7
Global Phys. Self-Concept	4.9	4.5	5.1	3.9	4.6
Appearance	4.4	3.7	4.0	3.4	4.5
Strength	4.9	4.1	4.7	3.9	4.6
Endurance	4.6	3.5	4.6	4.3	9.0
Self-Esteem	5.3	4.7	4.7	3.5	5.3
Flexibility	4.5	4.1	5.7	4.4	4.7

[1] 1997, elite athletes (basketball, tennis, volleyball, gymnastics, diving, swimming, synchronized swimming, soccer and softball).

[2] A- non-elite (water polo, track and field, basketball, soccer, cycling, swimming baseball, rugby, netball, cricket and aerobics).

B- elite (track and field, basketball, soccer, cycling, swimming, baseball, rugby, netball).

C- female high school students, non-athletes.

Table 24. Means and standard deviations for SPA scores in the present study and previous research.

		Age		SPA	
Study	n	M	SD	M	SD
Martin et al. (1997)		13.3	2.2		
elite soccer players	24			2.7	0.7
elite gymnasts	9			1.8	0.5
elite skaters	35			2.5	0.7
McAuley and Burman (1993)[1]	236	14.4	1.8	3.4	0.5
Crocker and Snyder (1997)[2]	114	16.4	2.4	2.6	0.8
Hart et al. (1989)[3]	114	18.4	5.6	3.1	0.8
Present study	135	16.6	3.1	2.7	0.7
11.0-15.9	68	13.5	0.3	2.5	0.4
16.0+	67	18.2	0.5	3.0	0.7

[1] Gymnasts.
[2] Basketball, tennis, gymnastics, volleyball, synchronized swimming, speed swimming, soccer, softball.
[3] Adult female non-athletes.

Table 25. Summary of descriptive statistics for EDI subscale scores in the present study and previous research.

	Garner et al. (1982)		Garner and Olmstead (1984)		Warren et al. (1990)				Rosen et al. (1990)		Skowron and Frielander (1994)		Present Study			
	College Women		Bulimic Anorexics		Adult Gymnasts		Adult Runners		Female Adolescent Norms		Gymnasts		Figure Skaters		Figure skaters 16+ years	
n	137		38		15		12		747		55		126		56	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Age	20.3		20.2		19.3	1.6	19.3	1.6	14.6	3.5	19.4	1.1	15.7	2.3	18.0	1.3
Body Dissatisfaction	9.7	8.1	15.5	7.8	12.1	5.9	5.6	7.0	11.3	7.7	9.8	7.9	6.9	7.4	9.0	7.3
Bulimia	1.7	3.1	8.1	6.3	1.4	1.6	0.8	1.6	2.1	3.3	1.5	2.2	1.7	3.5	2.6	4.5
Drive for Thinness	5.1	5.5	13.8	6.1	8.4	5.9	2.9	3.1	5.6	5.9	5.4	5.7	4.9	6.0	6.5	6.7
Ineffectiveness	2.3	3.8	12.1	8.6	1.0	2.1	4.3	0.6	4.2	5.1	1.5	2.2	3.5	2.5	3.4	2.6
Interpersonal Distrust	2.4	3.0	6.4	4.9	5.3	2.2	1.4	2.1	3.6	3.8	2.2	2.7	3.0	3.0	3.0	3.4
Introceptive Awareness	2.3	3.6	11.4	7.0	3.2	4.4	0.4	1.0	4.5	5.3	2.6	3.3	2.7	3.9	3.1	4.5
Maturity Fears	2.2	2.5	5.6	5.8	1.7	1.8	1.7	2.1	4.2	3.6	2.6	2.2	5.2	4.0	4.8	4.0
Perfectionism	6.4	4.3	8.6	5.3	7.3	5.3	4.9	3.0	5.2	4.3	6.8	3.8	5.9	4.0	6.3	4.3

Table 26. Anthropometric characteristics and somatotype of figure skaters by age group and level.

	Age Group						
	11.0-12.99						
Variable	Test			Pre-elite			Elite
n = 20	8			11			1
	M	SD	Md	M	SD	Md	
Age, yrs	12.3	0.5		12.3	0.5		11.5
Weight, kg	40.2	8.0	38.1	39.4	5.3	40.4	40.4
Stature, cm	149.2	6.2		150.5	6.8		147.2
BMI, kg/m^2	17.9	2.1	17.5	17.3	1.7	17.3	18.6
Sitting Height, cm	77.9	3.1		77.0	3.1		78.0
SH/ST ratio, %	52.2	1.3		51.2	1.2		52.9
Est. Leg Length, cm	71.3	4.0		73.5	4.8		69.4
Breadths, cm							
Bicondylar	8.2	0.5		8.2	0.4		8.8
Biepicondylar	5.8	0.2		5.8	0.3		5.8
Circumferences, cm							
Arm, relaxed	22.0	2.3		21.2	1.0		21.3
Arm, flexed	23.2	2.3		22.5	0.8		23.1
Calf	29.9	1.9		29.7	2.0		31.0
Thigh	46.1	3.6		45.2	2.5		46.4
EAMC, cm	19.6	1.8		19.6	1.1		21.6
ECMC, cm	28.4	1.5		28.9	1.5		33.0
Skinfolds, mm							
Triceps	10.1	2.6	9.7	9.4	1.7	8.8	11.0
Biceps	5.4	1.2	5.4	4.5	1.4	4.1	4.8
Subscapular	8.1	3.4	7.3	6.5	1.3	6.7	4.2
Supraspinale	8.7	3.6	7.3	6.7	2.0	6.1	5.4
Abdominal	8.9	4.1	7.9	8.2	3.7	7.3	7.4
Medial Calf	10.1	2.6	9.7	9.9	2.7	10.0	10.2
Sum of Skinfolds, mm	51.4	17.0	48.5	45.0	9.2	45.0	43.0
T/E Ratio, mm/mm	0.97	0.17	0.95	0.90	0.20	0.84	0.65
Somatotype							
Endomorphy	3.1	0.9		2.5	0.5		2.4
Mesomorphy	3.6	0.5		3.3	0.7		4.4
Ectomorphy	3.4	0.9		3.9	1.0		2.8

Table 26 (cont'd). Anthropometric characteristics and somatotype of figure skaters by age group and level.

	Age Group								
	13.0-14.9								
Variable	Test			Pre-elite			Elite		
n = 48	16			28			4		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	13.9	0.6		13.9	0.7		14.5	0.4	
Weight, kg	49.4	7.4	48.1	45.0	7.6	44.7	47.8	8.5	48.0
Stature, cm	157.9	4.1		154.3	5.9		157.3	5.9	
BMI, kg/m^2	19.7	2.5	18.6	18.9	2.1	18.6	19.9	2.1	19.7
Sitting Height, cm	83.1	3.7		80.5	3.7		83.7	3.0	
SH/ST ratio, %	52.6	1.5		52.2	1.3		53.2	0.4	
Est. Leg Length, cm	74.9	2.8		73.9	4.0		73.6	4.9	
Breadths, cm									
Bicondylar	8.7	0.6		8.5	0.6		8.3	0.4	
Biepicondylar	6.0	0.2		5.9	0.4		5.9	0.2	
Circumferences, cm									
Arm, relaxed	24.0	2.2		22.9	2.4		24.8	2.0	
Arm, flexed	25.2	1.9		24.3	2.2		26.2	2.3	
Calf	33.4	4.1		31.2	2.3		32.1	3.3	
Thigh	50.3	4.9		47.8	4.3		50.7	3.9	
EAMC, cm	20.9	1.7		21.7	1.9		19.5	2.5	
ECMC, cm	31.1	4.3		30.3	2.0		28.0	3.9	
Skinfolds, mm									
Triceps	13.4	4.4	13.6	10.7	3.7	9.6	14.0	4.4	14.0
Biceps	5.7	2.0	5.5	5.1	1.5	5.3	6.2	2.7	5.7
Subscapular	8.8	2.7	8.2	8.0	2.8	6.9	9.1	2.2	9.2
Supraspinale	9.7	4.2	9.6	9.0	4.1	8.7	10.4	5.4	9.0
Abdominal	12.5	6.0	10.4	9.4	3.7	8.8	12.2	5.4	12.1
Medial Calf	15.1	6.6	15.3	10.9	3.4	10.2	12.7	5.0	12.1
Sum of Skinfolds, mm	65.2	21.7	62.3	53.0	6.8	46.6	64.7	22.4	59.8
T/E Ratio, mm/mm	0.91	0.18	0.91	0.98	0.18	0.94	0.98	0.11	1.00
Somatotype									
Endomorphy	3.4	1.0		3.0	1.0		3.7	1.0	
Mesomorphy	3.8	0.8		3.6	0.8		3.6	1.2	
Ectomorphy	3.1	1.2		3.3	0.9		2.2	1.8	

Table 26 (cont'd). Anthropometric characteristics and somatotype of figure skaters by age group and level.

	Age Group								
	15.0-16.9								
Variable	Test			Pre-elite			Elite		
n = 43	14			16			13		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	16.0	0.6		15.9	0.7		16.0	0.6	
Weight, kg	55.5	8.9	56.2	49.5	7.9	50.4	52.6	5.4	49.9
Stature, cm	161.5	7.4		159.6	6.3		158.6	6.5	
BMI, kg/m^2	21.1	1.9	21.3	19.4	2.4	19.6	21.0	1.6	20.4
Sitting Height, cm	85.5	3.7		84.3	4.3		85.0	3.7	
SH/ST ratio, %	53.0	0.7		52.8	1.3		53.6	1.9	
Est. Leg Length, cm	75.9	4.0		75.3	3.2		73.6	4.9	
Breadths, cm									
Bicondylar	8.7	0.5		8.6	0.5		8.8	0.5	
Biepicondylar	6.0	0.5		6.0	0.5		6.0	0.3	
Circumferences, cm									
Arm, relaxed	25.3	2.2		23.8	2.3		25.2	1.5	
Arm, flexed	26.6	2.0		25.2	2.2		26.6	1.5	
Calf	33.9	3.0		32.2	2.5		32.9	1.0	
Thigh	53.6	4.8		50.4	4.6		53.6	3.0	
EAMC, cm	21.3	1.9		22.0	1.5		21.7	1.5	
ECMC, cm	31.2	2.8		30.9	1.8		30.6	1.7	
Skinfolds, mm									
Triceps	16.0	4.5	16.0	10.3	2.9	10.5	13.0	3.5	12.9
Biceps	6.1	1.6	5.9	4.9	1.5	4.8	6.0	3.6	5.4
Subscapular	11.4	3.5	11.4	8.1	2.8	8.3	9.3	2.9	8.3
Supraspinale	11.3	5.0	10.9	7.7	2.7	7.3	8.8	3.2	8.1
Abdominal	15.0	7.1	13.6	8.8	3.8	7.6	11.5	4.7	12.0
Medial Calf	14.3	4.1	14.7	11.1	3.1	10.8	13.0	4.3	12.3
Sum of Skinfolds, mm	74.0	18.3	77.7	51.0	14.5	49.2	61.5	15.7	58.1
T/E Ratio, mm/mm	1.06	0.37	0.96	0.93	0.18	0.90	0.94	0.21	0.91
Somatotype									
Endomorphy	4.1	0.9		2.8	0.8		3.4	0.9	
Mesomorphy	3.6	0.8		3.4	1.2		4.0	0.9	
Ectomorphy	2.5	0.7		3.4	1.2		2.4	1.0	

Table 26 (cont'd.). Anthropometric characteristics and somatotype of figure skaters by age group and level.

	Age Group								
	17+								
Variable	Test			Pre-elite			Elite		
n = 49	8			11			29		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	18.2	1.3		18.1	0.8		19.0	1.4	
Weight, kg	59.8	5.9	56.9	54.0	6.3	54.4	54.6	4.3	54.0
Stature, cm	163.6	6.4		162.3	4.9		160.3	4.6	
BMI, kg/m^2	22.3	1.3	22.2	20.5	1.9	20.7	21.2	1.0	21.0
Sitting Height, cm	88.6	3.9		86.4	3.1		85.6	1.0	
SH/ST ratio, %	54.2	1.9		53.2	0.8		53.4	1.1	
Est. Leg Length, cm	75.0	4.8		74.7	2.6		74.7	2.9	
Breadths, cm									
Bicondylar	8.7	0.4		8.9	0.2		8.8	0.5	
Biepicondylar	6.1	0.2		6.0	0.5		6.0	0.3	
Circumferences, cm									
Arm, relaxed	26.3	1.5		25.0	2.2		25.3	1.3	
Arm, flexed	27.5	1.5		26.1	2.0		26.7	1.4	
Calf	34.9	1.7		33.2	2.9		33.3	1.6	
Thigh	56.1	2.9		52.6	4.1		54.1	2.6	
EAMC, cm	21.6	1.7		22.1	2.2		21.8	1.7	
ECMC, cm	31.2	1.5		31.4	3.1		30.6	2.1	
Skinfolds, mm									
Triceps	17.6	4.2	15.7	12.3	4.7	11.8	13.2	3.7	13.0
Biceps	6.7	2.8	5.8	4.7	1.8	4.1	5.2	2.1	4.3
Subscapular	13.3	2.2	13.7	8.6	2.8	8.3	9.6	2.8	8.7
Supraspinale	12.8	5.3	10.5	8.2	3.4	6.7	9.2	4.3	7.9
Abdominal	15.1	3.3	15.5	11.1	4.9	7.7	9.7	3.6	9.2
Medial Calf	17.4	7.0	16.1	12.8	2.6	11.7	12.6	2.6	12.1
Sum of Skinfolds, mm	82.9	19.2	76.5	57.6	9.3	52.3	59.5	15.6	8.8
T/E Ratio, mm/mm	1.03	0.22	1.01	0.94	0.15	0.98	0.93	0.24	0.91
Somatotype									
Endomorphy	4.5	0.8		3.0	1.1		3.4	0.9	
Mesomorphy	3.7	0.9		3.5	0.9		3.9	0.6	
Ectomorphy	2.1	0.6		2.9	1.0		2.4	0.6	

Table 27. Anthropometric characteristics and somatotype in the total sample of figure skaters by level (n = 159).

	Level								
Variable	Test			Pre-elite			Elite		
n	46			66			47		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	15.0	2.1		14.8	2.0		17.7	2.2	
Weight, kg	51.7	10.0	54.0	46.4	8.6	46.3	53.9	5.4	52.6
Stature, cm	158.3	7.5		155.9	8.1		159.3	5.5	
BMI, kg/m^2	20.5	2.7	20.9	19.0	2.2	18.6	21.2	1.9	20.8
Sitting Height, cm	83.8	4.8		81.6	5.0		85.1	3.4	
SH/ST ratio, %	52.9	1.5		52.3	1.3		53.4	1.3	
Est. Leg Length, cm	74.5	3.9		74.3	4.2		74.2	3.4	
Breadths, cm									
Bicondylar	8.6	0.7		8.5	0.7		8.8	0.5	
Biepicondylar	6.0	0.3		5.9	0.5		6.0	0.3	
Circumferences, cm									
Arm, relaxed	24.6	2.8		23.1	2.5		25.2	1.5	
Arm, flexed	25.8	2.6		24.4	2.3		26.5	1.6	
Calf	33.3	3.5		31.4	2.8		33.1	1.7	
Thigh	51.9	5.6		48.6	4.9		53.5	3.1	
EAMC, cm	20.9	1.9		21.5	2.0		21.6	1.8	
ECMC, cm	30.6	3.2		30.3	2.2		30.5	2.3	
Skinfolds, mm									
Triceps	14.6	5.0	14.4	10.6	3.5	9.9	13.1	3.6	12.9
Biceps	6.1	2.2	5.8	4.9	1.5	4.8	5.5	2.6	4.7
Subscapular	10.6	4.2	9.9	7.8	2.6	7.0	9.4	2.8	8.5
Supraspinale	10.8	5.0	9.7	8.1	3.4	7.7	9.1	4.1	7.9
Abdominal	13.2	6.0	11.5	9.3	4.0	7.8	10.4	4.1	9.2
Medial Calf	14.8	6.2	14.0	11.0	3.5	10.3	12.7	3.4	12.1
Sum of Skinfolds, mm	70.1	23.8	67.9	51.7	15.9	47.1	60.1	16.0	55.9
T/E Ratio, mm/mm	1.00	0.31	0.94	1.01	0.24	0.91	0.92	0.21	0.91
Somatotype									
Endomorphy	3.8	1.1		2.9	0.9		2.4	0.9	
Mesomorphy	3.7	0.8		3.5	0.9		3.9	0.8	
Ectomorphy	2.7	1.1		3.3	1.1		2.3	0.9	

Table 28. Results of the ANCOVA, with age as the covariate, and age-adjusted means and standard errors for anthropometric characteristics and somatotype[1] of figure skaters by level (n = 159).

		Level					
		1.Test (n = 46)		2. Pre-elite (n = 66)		3. Elite (n = 47)	
Variable	F(2)	^{Adj}M	SE	^{Adj}M	SE	^{Adj}M	SE
Weight, kg	6.2*	53.0[a]	1.1	48.1	0.9	50.1	1.2
Stature, cm	2.5	159.4	1.0	157.2	0.8	156.3	1.1
BMI, kg/m^2	6.5*	20.7[a]	0.3	19.3[c]	0.3	20.5	0.3
Sitting Height, cm	3.7*	84.6[ab]	0.6	82.6	0.5	83.0	0.6
SH/ST ratio, %	3.4*	53.1[a]	0.0	52.5[c]	0.0	53.1	0.0
Est. leg length, cm	1.7	74.8	0.6	74.7	0.5	73.3	0.6
Breadths, cm							
Bicondylar	0.5	8.6	0.9	8.5	0.8	8.7	0.1
Biepicondylar	0.7	6.0	0.1	5.9	0.5	5.9	0.6
Circumferences, cm							
Arm, relaxed	6.2*	25.0[ab]	0.3	23.5[c]	0.3	24.2	0.3
Arm, flexed	5.9*	26.1[a]	0.3	24.8[c]	0.3	25.6	0.3
Calf	7.3*	33.6[ab]	0.4	31.8	0.3	32.1	0.4
Thigh	7.6*	52.6[a]	0.6	49.6[c]	0.5	51.3	0.7
EAMC, cm	4.2*	21.1[a]	0.3	21.7[c]	0.3	21.2	0.3
ECMC, cm	5.5*	30.8[ab]	0.4	30.5	0.4	29.9	0.5
Skinfolds, mm							
Triceps	14.0*	14.9[ab]	0.6	10.9[c]	0.5	12.3	0.6
Biceps	4.9*	6.1[ab]	0.3	4.9	0.3	5.4	0.3
Subscapular	11.6*	10.9[ab]	0.5	8.3	0.4	8.4	0.5
Supraspinale	6.3*	11.0[ab]	0.6	8.3	0.5	8.6	0.7
Abdominal	11.1*	13.5[b]	0.7	9.6	0.6	9.7	0.8
Medial Calf	10.4*	15.0[ab]	0.7	11.3	0.6	12.0	0.7
Sum of Skinfolds, mm	14.5*	71.4[ab]	2.7	53.4	2.3	56.5	3.0
T/E Ratio, mm/mm	1.8	1.00	0.03	1.00	0.03	0.90	0.03
Somatotype							
Endomorphy[1]	12.8*	3.6[ab]	0.1	3.2	0.1	3.1	0.1
Mesomorphy[1]	1.3	3.7	0.1	3.7	0.1	3.7	0.1
Ectomorphy[1]	2.9*	3.0[b]	0.1	3.0[c]	0.1	2.7	0.2

* $p < .05$.

[1]Univariate post hoc comparisons adjusted for the univariate post hoc comparison using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 for MANCOVA (Cressie et al., 1986).

[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 29. Scores for the PSDQ and EDI subscales and for the SPAS of figure skaters by age group and level.

	Age Group						
	11.0-12.9						
Variable	Test			Pre-elite			Elite
PSDQ	M	SD	Md	M	SD	Md	
n = 12		2			9		1
Age	12.1	0.5		12.3	0.3		11.5
Health	5.0	1.1		5.0	0.8		4.9
Coordination	4.6	0.8		5.3	0.4		5.7
Physical Activity	3.6	0.4		5.2	0.7		5.2
Body Fat	5.1	1.2		5.5	0.5		6.0
Sport Competence	4.3	1.8		5.3	0.7		4.7
Global Phys. Self-Concept	4.9	1.3		5.3	1.0		5.2
Appearance	4.7	0.7		4.6	1.1		5.0
Strength	4.3	0.8		5.2	0.6		5.5
Endurance	9.3	1.5		9.7	0.6		9.8
Self-Esteem	4.9	1.0		5.8	0.1		5.8
Flexibility	4.7	1.9		5.3	0.3		5.7
EDI							
n = 11		3			7		1
Age	12.1	0.7		12.4	0.1		11.5
Body Dissatisfaction	0.7	0.6	1.0	0.5	0.5	0.5	0.0
Bulimia	0.0	0.0	0.0	0.5	1.0	0.0	0.0
Drive for Thinness	0.3	0.5	0.0	1.8	2.7	0.0	3.0
Ineffectiveness	1.7	0.6	2.0	3.8	1.2	3.0	4.0
Interpersonal Distrust	2.7	2.7	1.0	2.8	2.5	2.5	0.0
Introceptive Awareness	1.3	1.2	2.0	2.0	2.6	1.0	0.0
Maturity Fears	4.7	1.2	4.0	7.5	3.9	7.5	5.0
Perfectionism	2.0	2.0	2.0	7.9	3.9	6.5	7.0
SPA							
n = 16		5			10		1
Age	12.2	0.3		12.3	0.3		11.5
SPA	2.5	0.3		2.3	0.5		1.9

Table 29 (cont'd). Scores for the PSDQ and EDI subscales and for the SPAS of figure skaters by age group and level.

	Age Group								
	13.0-14.9								
Variable	Test			Pre-elite			Elite		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 26		12			21			4	
Age	13.9	0.8		13.9	0.7		14.1	0.4	
Health	4.9	0.7		4.9	0.7		4.9	0.5	
Coordination	4.8	0.8		4.7	1.0		4.7	1.2	
Physical Activity	4.9	0.9		4.8	1.1		5.4	1.1	
Body Fat	5.5	0.8		5.2	1.1		3.9	0.1	
Sport Competence	5.0	0.9		4.9	0.9		4.9	0.6	
Global Phys. Self-Concept	4.8	0.8		5.2	0.8		4.6	1.4	
Appearance	4.6	0.7		4.7	0.9		4.4	1.4	
Strength	4.7	0.6		4.6	0.8		4.2	1.5	
Endurance	8.7	1.1		9.2	0.8		9.4	0.9	
Self-Esteem	5.4	0.4		5.4	0.5		4.9	0.5	
Flexibility	4.6	0.9		4.7	1.1		4.9	0.7	
EDI									
Age	14.0	0.5		13.9	0.6		14.3	0.8	
n = 39		12			23			4	
Body Dissatisfaction	3.5	4.5	1.5	3.6	4.7	1.5	13.0	1.4	12.0
Bulimia	1.9	2.7	1.0	0.3	0.8	1.0	0.8	1.0	0.5
Drive for Thinness	2.3	4.2	0.5	2.5	3.0	0.5	8.8	6.6	9.0
Ineffectiveness	3.3	2.0	3.0	3.0	2.0	3.0	4.3	4.0	3.0
Interpersonal Distrust	4.3	3.9	3.0	2.7	2.8	3.0	3.0	2.2	3.5
Introceptive Awareness	2.3	3.4	1.0	1.4	2.1	1.0	4.0	2.7	5.0
Maturity Fears	6.3	5.7	4.5	4.7	3.6	4.5	5.5	2.5	5.0
Perfectionism	6.6	3.4	6.0	4.8	3.5	6.0	4.3	3.3	3.0
SPA									
N = 38		12			22			4	
Age	14.0	0.4		13.4	0.7		14.0	0.7	
SPA	2.7	0.7		2.3	0.6		3.2	0.8	

Table 29 (cont'd). Scores for the PSDQ and EDI subscales and for the SPAS of figure skaters by age group and level.

	Age Group								
	15.0-16.9								
Variable	Test			Pre-elite			Elite		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
N = 31		14			13			4	
Age	16.0	0.6		15.9	0.7		16.0	0.6	
Health	4.6	0.7		4.7	1.0		4.7	0.6	
Coordination	4.8	0.9		4.6	0.7		4.7	1.0	
Physical Activity	4.8	1.0		4.7	1.1		5.7	0.3	
Body Fat	3.6	1.5		4.8	1.5		5.0	1.3	
Sport Competence	4.4	0.9		4.9	0.9		4.6	0.5	
Global Phys. Self-Concept	3.9	1.1		4.5	1.1		5.0	0.8	
Appearance	3.8	1.1		4.2	1.0		4.8	0.7	
Strength	4.1	0.8		4.7	0.9		4.9	0.4	
Endurance	8.5	1.1		9.1	1.0		9.3	1.1	
Self-Esteem	4.8	0.9		5.2	0.7		5.2	0.7	
Flexibility	5.1	0.8		4.7	1.1		4.6	1.0	
EDI									
n = 37		15			14			8	
Age	16.1	0.4		16.0	0.7		16.1	0.6	
Body Dissatisfaction	13.5	8.6	11.0	7.6	8.2	1.0	6.2	8.2	2.5
Bulimia	3.2	5.3	1.0	3.1	4.7	2.5	1.1	1.6	0.0
Drive for Thinness	8.0	7.6	5.5	5.6	6.6	5.5	3.9	6.4	0.0
Ineffectiveness	4.8	3.9	3.0	3.8	2.5	3.0	3.0	0.9	3.0
Interpersonal Distrust	2.9	2.8	2.5	4.1	4.2	3.5	2.4	2.0	2.0
Introceptive Awareness	4.1	4.7	3.0	3.5	4.1	2.5	1.3	0.7	1.0
Maturity Fears	7.0	4.6	6.0	5.2	4.0	5.0	3.6	1.5	4.0
Perfectionism	7.1	4.5	5.5	5.4	3.3	5.0	5.0	3.1	5.0
SPA									
n = 38		13			13			12	
Age	16.4	0.3		15.9	0.3		16.2	0.9	
SPA	3.1	0.8		2.5	1.0		2.9	0.6	

Table 29 (cont'd). Scores for the PSDQ and EDI subscales and for the SPAS of figure skaters by age group and level.

	Age Group								
	17+								
Variable	Test			Pre-elite			Elite		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 43		8			11			24	
Age	18.2	1.3		18.1	0.8		19.0	1.4	
Health	4.5	0.6		4.5	1.2		4.4	1.1	
Coordination	4.1	0.5		4.2	1.2		4.9	0.4	
Physical Activity	4.8	0.7		5.2	0.6		5.5	0.5	
Body Fat	4.0	1.0		5.0	1.1		4.3	1.4	
Sport Competence	4.3	0.9		3.8	1.1		4.8	0.7	
Global Phys. Self-Concept	4.3	0.9		4.5	1.1		4.3	1.2	
Appearance	4.4	0.6		4.8	0.5		4.5	0.7	
Strength	4.5	0.7		3.9	1.1		4.8	0.8	
Endurance	8.5	0.5		8.5	1.0		9.1	1.0	
Self-Esteem	4.7	0.6		5.2	0.5		5.3	0.6	
Flexibility	4.1	0.5		5.1	0.8		4.7	1.1	
EDI									
n = 39		7			9			23	
Age	18.0	1.1		18.1	0.8		19.2	1.4	
Body Dissatisfaction	5.8	5.1	5.5	8.1	5.6	9.0	10.1	7.6	10.0
Bulimia	0.6	1.4	0.0	5.0	7.2	1.0	1.4	2.3	0.0
Drive for Thinness	4.3	4.8	2.0	6.8	5.6	4.0	7.0	7.2	6.0
Ineffectiveness	3.3	2.7	2.0	2.7	1.6	3.0	3.4	2.8	3.0
Interpersonal Distrust	2.5	2.1	3.0	5.6	5.7	3.0	1.9	2.2	1.0
Introceptive Awareness	1.6	3.8	0.0	4.4	7.2	1.0	3.4	4.3	2.0
Maturity Fears	4.3	3.6	3.0	5.7	6.2	2.0	4.0	3.1	3.0
Perfectionism	6.0	4.1	5.0	7.7	6.3	5.0	5.7	4.2	5.0
SPA									
n = 41		8			10			23	
Age	18.5	1.5		18.0	0.8		19.3	1.2	
SPA	2.8	0.6		2.8	0.5		3.1	0.7	

Table 30. Scores for the PSDQ and EDI subscales, and the SPAS of figure skaters by level.

	Level								
Variable	Test			Pre-elite			Elite		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 128		36			56			36	
Age	15.5	1.8		15.0	2.0		17.6	2.1	
Health	4.8	0.8		4.8	0.8		4.5	1.0	
Coordination	4.7	0.8		4.7	1.0		4.8	0.5	
Physical Activity	4.7	0.8		4.9	1.0		5.5	0.5	
Body Fat	4.4	1.9		5.1	1.1		4.4	1.4	
Sport Competence	4.6	0.9		4.7	1.0		4.8	0.6	
Global Phys. Self-Concept	4.3	1.1		4.9	1.0		4.5	1.1	
Appearance	4.1	0.9		4.5	0.9		4.6	0.7	
Strength	4.4	0.7		4.6	0.9		4.7	0.8	
Endurance	8.6	1.0		9.1	0.9		9.1	1.0	
Self-Esteem	5.0	1.0		5.4	0.6		5.3	0.6	
Flexibility	4.7	0.9		4.9	1.0		4.7	1.0	
EDI									
n = 126		37			53			36	
Age	15.2	1.8		15.0	2.5		17.4	2.0	
Body Dissatisfaction	2.0	3.8	5.0	1.9	4.1	3.0	1.2	2.0	7.5
Bulimia	3.7	3.0	1.0	3.2	2.0	0.0	3.4	2.5	0.0
Drive for Thinness	3.2	3.0	2.0	3.5	3.9	2.0	2.1	2.1	5.0
Ineffectiveness	2.8	3.9	3.0	2.5	4.0	3.0	2.9	3.7	3.0
Interpersonal Distrust	6.0	4.6	3.0	5.4	4.2	3.0	4.1	2.7	2.0
Introceptive Awareness	6.2	4.0	1.0	5.9	4.1	1.0	5.4	3.8	2.0
Maturity Fears	4.7	6.2	5.0	3.9	4.9	4.0	6.4	6.9	4.0
Perfectionism	7.6	7.9	5.0	4.9	6.1	5.0	9.3	8.3	5.0
SPA									
n = 135		38			55			42	
Age	15.6	1.8		14.9	2.1		17.4	2.2	
SPA	2.8	0.7		2.4	0.7		3.0	0.7	

Table 31. Results of the MANCOVA, with age as a covariate for the PSDQ, EDI and the ANCOVA, with age as the covariate for SPA by level.

Variable	Pillai's	df	F
Age Covariate			
PSDQ	0.21	11	2.8*
EDI	0.18	8	3.2*
Level			
PSDQ	0.29	22	1.8*
EDI	0.21	16	1.5

		Level					
		1. Test		2. Pre-elite		3. Elite	
Variable	F(1)	^{Adj}M	SE	^{Adj}M	SE	^{Adj}M	SE
PSDQ (n = 128)		(n = 36)		(n = 56)		(n = 36)	
Health	0.1	4.7	0.1	4.7	0.1	4.6	0.2
Coordination	2.3	4.7	0.1	4.6	0.1	5.0	0.1
Physical Activity	5.9*	4.8[b]	0.1	4.9[c]	0.1	5.5	0.2
Body Fat	2.9	4.4	0.2	4.9	0.2	4.7	0.2
Sport Competence	2.8	4.6	0.1	4.6	0.1	5.1	0.2
Global Phys. Self-Concept	3.0	4.3	0.2	4.8	0.1	4.8	0.2
Appearance	3.2*	4.2[ab]	0.2	4.5	0.1	4.7	0.2
Strength	2.7	4.4	0.1	4.5	0.1	4.9	0.2
Endurance	5.9*	8.6[ab]	0.2	9.0[c]	0.1	9.4	0.2
Self-Esteem	4.3*	5.0[ab]	0.1	5.3	0.1	5.4	0.1
Flexibility	0.3	4.7	0.2	4.8	0.1	4.7	0.2
EDI (n = 126)		(n = 37)		(n = 53)		(n = 36)	
Body Dissatisfaction	4.0	7.6	1.1	4.9	1.0	9.3	1.2
Bulimia	0.5	2.0	0.6	1.9	0.5	1.2	0.6
Drive for Thinness	1.9	4.7	1.0	3.9	0.8	6.4	1.0
Ineffectiveness	0.4	3.7	0.4	3.3	0.3	3.4	0.4
Interpersonal Distrust	2.4	3.2	0.5	3.5	0.4	2.1	0.5
Introceptive Awareness	0.1	2.8	0.6	2.5	0.5	2.9	0.7
Maturity Fears	2.1	6.0	0.7	5.4	0.5	4.1	0.7
Perfectionism	0.4	6.3	0.7	5.9	0.5	5.4	0.7
SPAS (n = 135)		(n = 38)		(n = 55)		(n = 42)	
SPA	5.1*	2.9[a]	0.1	2.5[c]	0.1	2.9	0.1

* $p < .05$.

[a]1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 32. Distribution of recalled ages at menarche, mean ages at menarche, and results of ANOVA for figure skaters $\geq$16.0 years by level (n = 67).

	Level		
	1. Test (n = 15)	2. Pre-elite (n = 16)	3. Elite (n = 36)
Age Range			
10.00-10.99	0	0	1
11.00-11.99	1	0	0
12.00-12.99	7	4	6
13.00-13.99	6	8	12
14.00-14.99	1	3	7
15.00-15.99	0	0	7
16.00-16.99	0	1	3
M	12.9[a]	13.5	14.0
SD	0.8	0.9	1.4
$F(2) = 4.8, p < .01$			

[a] 1 differs from 3.

Table 33. Anthropometric characteristics of figure skaters by age group and discipline.

	Age Group						
	11.0-12.99						
Variable	Free			Dance	Pairs		
n = 20	16			1	3		
	M	SD	Md		M	SD	Md
Age, yrs	12.2	0.5		12.8	12.7	0.3	
Weight, kg	39.4	6.6	38.8	47.6	38.7	2.1	39.5
Stature, cm	149.0	6.2		153.1	153.0	7.2	
BMI, kg/m^2	17.7	1.8	17.6	20.3	16.5	0.7	16.3
Sitting Height, cm	77.5	2.7		78.4	76.3	2.1	
SH/ST ratio, %	52.0	1.1		51.2	49.9	1.1	
Est. Leg Length, cm	71.5	4.1		74.7	76.7	5.2	
Breadths, cm							
Bicondylar	8.2	0.4		8.0	8.1	0.2	
Biepicondylar	5.8	0.3		5.5	5.7	0.1	
Circumferences, cm							
Arm, relaxed	21.4	1.7		22.2	22.1	1.0	
Arm, flexed	22.8	1.7		23.3	22.6	0.7	
Calf	29.7	2.1		30.6	29.9	0.5	
Thigh	45.5	3.2		46.4	45.8	1.1	
EAMC, cm	19.7	1.6		20.3	19.5	0.9	
ECMC, cm	29.0	1.9		28.6	28.5	0.7	
Skinfolds, mm							
Triceps	9.8	2.2	9.0	8.2	10.2	2.1	11.1
Biceps	4.7	1.3	4.7	3.7	6.2	1.4	5.5
Subscapular	7.1	2.8	6.6	7.9	6.5	0.6	6.7
Supraspinale	7.4	3.0	6.6	5.3	7.9	2.3	9.1
Abdominal	7.7	3.3	7.1	7.4	12.9	3.4	14.6
Medial Calf	9.9	2.6	10.1	12.5	9.4	2.0	8.5
Sum of Skinfolds, mm	46.6	13.9	44.8	45.1	53.1	5.0	55.9
T/E Ratio, mm/mm	0.89	0.18	0.87	0.85	1.07	0.29	1.19
Somatotype							
Endomorphy	2.8	0.8		2.4	2.7	0.5	
Mesomorphy	3.6	0.5		2.9	2.9	0.9	
Ectomorphy	3.6	0.9		2.3	4.5	1.0	

Table 33 (cont'd). Anthropometric characteristics of figure skaters by age group and discipline.

	Age Group								
	13.0-14.9								
Variable	Free			Dance			Pairs		
n = 48	36			6			6		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	14.0	0.7		13.9	0.7		13.8	0.6	
Weight, kg	48.6	7.2	47.4	41.4	8.9	38.8	40.7	4.2	42.2
Stature, cm	157.1	5.0		152.0	9.8		151.5	4.2	
BMI, kg/m^2	19.7	2.2	19.4	18.1	2.2	17.4	17.7	1.4	18.0
Sitting Height, cm	82.5	3.5		79.7	5.0		78.1	0.9	
SH/ST ratio, %	52.5	1.4		52.4	3.3		51.6	1.5	
Est. Leg Length, cm	74.6	3.2		72.3	4.8		73.4	4.2	
Breadths, cm									
Bicondylar	8.6	0.7		8.4	0.4		8.6	0.4	
Biepicondylar	6.0	0.3		5.6	0.3		6.0	0.4	
Circumferences, cm									
Arm, relaxed	23.8	2.3		22.3	2.8		22.5	2.0	
Arm, flexed	25.1	2.1		23.6	2.1		23.9	1.9	
Calf	32.7	3.2		30.0	2.7		29.8	1.3	
Thigh	49.8	4.4		45.8	5.1		46.0	1.7	
EAMC, cm	21.1	2.0		22.1	1.2		21.6	2.3	
ECMC, cm	30.5	3.5		30.4	1.3		29.8	2.4	
Skinfolds, mm									
Triceps	12.8	4.1	12.3	10.4	3.9	10.1	8.1	0.5	7.9
Biceps	5.6	1.9	5.4	4.9	1.5	4.5	4.6	0.9	5.0
Subscapular	8.7	2.5	8.4	8.1	4.4	6.8	6.4	0.1	6.4
Supraspinale	9.8	4.2	9.1	8.4	5.5	7.0	7.3	1.5	7.9
Abdominal	11.3	5.0	9.9	9.3	5.4	8.5	8.2	1.3	8.6
Medial Calf	13.6	5.3	13.2	10.3	3.1	9.4	7.9	1.3	7.1
Sum of Skinfolds, mm	61.8	19.3	59.3	51.5	23.0	46.1	42.5	3.2	44.4
T/E Ratio, mm/mm	0.94	0.17	0.94	0.96	0.24	0.87	1.06	0.16	1.07
Somatotype									
Endomorphy	3.4	1.0		2.9	0.7		2.4	0.3	
Mesomorphy	3.7	0.9		3.3	0.6		4.0	0.6	
Ectomorphy	2.9	1.2		3.7	0.5		3.7	0.8	

Table 33 (cont'd). Anthropometric characteristics of figure skaters by age group and discipline.

	Age Group								
	15.0-16.9								
Variable	Free			Dance			Pairs		
n = 43	28			9			6		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	15.9	0.6		16.1	0.6		16.2	0.7	
Weight, kg	53.1	8.0	54.0	52.8	9.9	56.7	49.1	0.9	49.0
Stature, cm	160.2	6.7		162.0	6.7		155.2	2.7	
BMI, kg/m^2	20.6	2.1	21.1	20.0	3.0	20.1	20.4	0.9	20.4
Sitting Height, cm	85.1	3.5		85.2	5.5		83.6	2.6	
SH/ST ratio, %	53.1	1.2		52.6	1.6		53.8	1.5	
Est. Leg Length, cm	75.1	4.1		76.8	3.8		71.6	2.7	
Breadths, cm									
Bicondylar	8.7	0.5		9.0	0.5		8.5	0.4	
Biepicondylar	6.1	0.4		6.0	0.4		5.8	0.3	
Circumferences, cm									
Arm, relaxed	24.8			24.4	2.9		24.9	1.1	
Arm, flexed	26.1	2.0		25.8	2.7		26.3	0.7	
Calf	33.2	2.6		32.4	2.5		32.9	1.1	
Thigh	52.7	4.3		51.7	6.1		51.9	1.4	
EAMC, cm	21.4	1.7		22.3	1.6		22.0	1.4	
ECMC, cm	30.9	2.3		30.6	2.1		31.3	1.6	
Skinfolds, mm									
Triceps	14.0	4.8	13.3	10.8	2.4	11.4	11.2	2.5	11.1
Biceps	5.5	1.6	5.8	5.5	1.5	5.8	5.2	2.7	4.7
Subscapular	9.7	3.2	8.6	9.7	4.0	9.0	8.6	3.1	7.5
Supraspinale	9.8	4.2	8.4	8.7	3.2	9.4	7.2	1.5	7.1
Abdominal	12.7	6.3	11.8	9.9	4.1	12.0	9.2	4.7	7.5
Medial Calf	13.4	4.4	13.3	12.1	2.4	12.1	10.5	3.0	11.1
Sum of Skinfolds, mm	65.1	19.1	64.1	56.7	15.8	64.2	51.9	14.6	51.4
T/E Ratio, mm/mm	0.99	0.30	0.95	0.97	0.23	0.90	0.90	0.14	0.91
Somatotype									
Endomorphy	3.6	1.0		3.1	0.9		3.0	0.7	
Mesomorphy	3.6	1.0		3.5	1.1		4.1	0.3	
Ectomorphy	2.7	1.0		3.2	1.6		2.4	0.6	

Table 33 (cont'd). Anthropometric characteristics of figure skaters by age group and discipline.

	Discipline								
	17+								
Variable	Free			Dance			Pairs		
n = 48	27			13			8		
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	18.4	1.2		19.0	1.7		19.1	0.9	
Weight, kg	58.2	4.3	57.6	52.2	5.4	52.6	50.8	1.5	49.8
Stature, cm	162.5	4.8		161.4	5.2		157.3	3.7	
BMI, kg/m^2	22.0	1.2	22.0	20.0	1.2	20.6	20.6	0.6	20.8
Sitting Height, cm	87.4	3.0		86.1	3.3		82.7	2.5	
SH/ST ratio, %	53.8	1.3		53.4	1.0		52.6	1.0	
Est. Leg Length, cm	75.0	3.3		75.3	2.8		74.5	2.4	
Breadths, cm									
Bicondylar	8.9	0.4		8.9	0.6		8.7	0.2	
Biepicondylar	6.1	0.2		5.9	0.4		5.8	0.3	
Circumferences, cm									
Arm, relaxed	26.1	1.3		24.4	1.8		24.5	0.5	
Arm, flexed	27.3	1.4		25.7	1.8		26.1	0.7	
Calf	34.3	1.5		32.5	2.8		32.7	1.1	
Thigh	55.3	2.7		52.4	4.0		52.8	0.8	
EAMC, cm	21.6	2.0		22.4	1.6		21.8	0.8	
ECMC, cm	30.8	2.4		30.9	2.5		31.4	1.3	
Skinfolds, mm									
Triceps	15.5	4.1	15.0	11.9	4.2	9.8	10.6	1.6	9.8
Biceps	6.2	2.5	5.7	4.3	1.2	4.1	4.1	0.6	4.2
Subscapular	11.0	3.2	10.5	8.7	2.6	8.5	8.6	1.8	8.3
Supraspinale	11.4	5.0	10.3	7.4	2.7	6.8	7.1	1.5	7.5
Abdominal	12.4	4.7	12.9	9.1	3.7	7.0	8.9	0.9	9.2
Medial Calf	14.3	4.9	13.7	12.8	3.8	12.3	11.4	2.2	10.9
Sum of Skinfolds, mm	70.8	19.6	70.9	54.3	16.0	52.3	50.5	4.0	49.8
T/E Ratio, mm/mm	0.97	0.25	0.97	0.89	0.19	0.91	0.95	0.15	0.99
Somatotype									
Endomorphy	4.0	1.0		3.0	0.9		2.9	0.4	
Mesomorphy	3.9	0.7		3.4	0.8		3.9	0.6	
Ectomorphy	2.1	0.6		3.1	0.6		2.5	0.5	

Table 34. Anthropometric characteristics and somatotype of figure skaters by discipline (n = 159).

	Discipline								
Variable		Free			Dance			Pairs	
n		107			29			23	
	M	SD	Md	M	SD	Md	M	SD	Md
Age, yrs	15.3	2.3		16.8	2.5		16.1	2.6	
Weight, kg	51.0	9.2	53.5	50.0	8.7	51.3	46.1	5.6	48.5
Stature, cm	157.7	7.6		159.3	7.9		154.7	4.5	
BMI, kg/m^2	20.4	2.6	20.7	19.6	2.1	20.2	19.3	1.8	19.6
Sitting Height, cm	83.5	4.8		84.2	5.0		80.9	3.5	
SH/ST ratio, %	53.0	1.0		52.9	1.2		52.2	2.1	
Est. Leg Length, cm	74.2	4.0		75.1	3.8		73.8	3.4	
Breadths, cm									
Bicondylar	8.6	0.7		8.8	0.6		8.5	0.3	
Biepicondylar	6.0	0.4		5.8	0.4		5.9	0.3	
Circumferences, cm									
Arm, relaxed	24.3	2.7		23.9	2.4		23.8	1.7	
Arm, flexed	25.6	2.5		25.2	2.3		25.1	1.8	
Calf	32.8	3.1		31.9	2.7		31.6	1.8	
Thigh	51.3	5.3		50.6	5.4		49.9	3.4	
EAMC, cm	24.3	2.3		24.1	2.1		24.1	1.7	
ECMC, cm	31.4	2.9		30.7	2.5		30.6	1.7	
Skinfolds, mm									
Triceps	13.4	4.6	12.7	11.1	3.5	10.4	10.0	2.0	9.7
Biceps	5.6	2.1	5.5	4.8	1.4	4.3	5.1	2.9	4.5
Subscapular	9.4	3.6	8.5	8.9	3.4	7.9	7.7	2.1	6.7
Supraspinale	9.9	4.6	9.0	8.0	3.5	7.7	7.2	1.6	7.5
Abdominal	11.4	5.3	9.9	9.3	4.0	7.4	9.3	3.0	8.9
Medial Calf	13.3	5.1	12.2	12.1	3.2	12.1	10.0	2.5	10.1
Sum of Skinfolds, mm	63.1	21.4	55.3	54.2	16.8	51.0	49.4	9.8	48.6
T/E Ratio, mm/mm	0.96	0.22	0.94	0.95	0.21	0.93	1.0	0.10	0.92
Somatotype									
Endomorphy	3.5	1.1		3.0	1.0		2.8	0.5	
Mesomorphy	3.7	0.9		3.4	0.8		3.8	0.7	
Ectomorphy	2.8	1.1		3.2	1.0		3.1	1.0	

Table 35. Results of the ANCOVA, with age as the covariate, and age-adjusted means and standard errors for anthropometric characteristics and somatotype[1] of figure skaters by discipline (n = 159).

		Discipline					
		1. Free (n = 107)		2. Dance (n = 29)		3. Pairs (n = 23)	
	F(2)	^{Adj}M	SE	^{Adj}M	SE	^{Adj}M	SE
Weight, kg	10.1*	51.8[ab]	0.7	47.6	1.3	45.2	1.5
Stature, cm	4.0*	158.3[b]	0.6	157.8[c]	1.2	154.1	1.4
BMI, kg/m^2	8.8*	20.6[ab]	0.2	19.0	0.4	19.0	0.4
Sitting Height, cm	8.0*	84.0[b]	0.4	83.0[c]	0.7	80.4	0.8
SH/ST ratio, %	4.3*	53.0[ab]	0.0	52.6[c]	0.0	52.2	0.0
Est. leg length, cm	0.56	74.3	0.4	74.8	0.7	73.6	0.8
Breadths, cm							
Bicondylar	0.8	8.6	0.1	8.7	0.1	8..5	0.2
Biepicondylar	4.6*	6.0[ab]	0.0	5.8	0.1	5.8	0.1
Circumferences, cm							
Arm, relaxed	4.7*	24.5[ab]	0.2	23.3	0.4	23.5	0.4
Arm, flexed	4.9*	25.8[ab]	0.2	24.6	0.4	24.9	0.4
Calf	6.2*	33.0[ab]	0.3	31.3	0.5	31.4	0.5
Thigh	6.4*	51.8[ab]	0.4	49.2	0.8	49.3	0.9
EAMC, cm	3.3*	21.1[a]	0.2	21.7	0.4	21.4	0.4
ECMC, cm	4.9	30.4	0.3	30.0	0.6	30.4	0.5
Skinfolds, mm							
Triceps	12.9*	13.6[ab]	0.4	10.4	0.7	9.7	0.8
Biceps	2.3	5.7	0.2	4.7	0.4	5.1	0.4
Subscapular	4.8*	9.6[b]	0.3	8.3	0.6	7.5	0.7
Supraspinale	7.2*	10.1[ab]	0.4	7.6	0.8	7.1	0.9
Abdominal	4.7*	11.6[ab]	0.5	8.9	0.9	9.1	1.0
Medial Calf	6.6*	13.4[ab]	0.4	11.6[c]	0.9	9.8	0.9
Sum of Skinfolds, mm	9.0*	63.9[ab]	1.8	51.8	3.6	48.5	3.9
T/E Ratio, mm/mm	0.6	0.96	0.02	0.92	0.04	0.98	0.05
Somatotype							
Endomorphy[1]	8.9*	3.4[ab]	0.1	3.1	0.1	3.0	0.2
Mesomorphy[1]	2.6*	3.7[b]	0.1	3.6[c]	0.1	3.9	.01
Ectomorphy[1]	1.1	2.9	0.1	3.0	0.1	3.0	0.1

* $p < .05$.
[1] Univariate post hoc comparisons adjusted for the univariate post hoc comparison using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 for MANCOVA (Cressie et al., 1986).
[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 36. Scores on the PSDQ and EDI subscales and for SPA of figure skaters by age group and discipline.

	Age Group					
	11.0-12.9					
Variable	Free			Dance	Pairs	
PSDQ	M	SD	Md	M	M	SD
n = 128		8		1	3	
Age	12.2	0.5		12.8	12.7	0.3
Health	4.8	0.9		5.6	5.3	0.6
Coordination	5.1	0.6		5.7	5.3	0.5
Physical Activity	4.9	1.0		5.3	4.9	1.0
Body Fat	5.5	0.7		6.0	5.2	0.7
Sport Competence	5.1	1.0		4.2	4.8	1.1
Global Phys. Self-Concept	5.5	0.7		6.0	4.3	1.2
Appearance	4.6	1.0		5.8	4.4	0.5
Strength	5.0	0.7		6.0	4.9	1.0
Endurance	9.7	0.7		10.3	9.1	0.1
Self-Esteem	5.6	0.6		5.9	5.8	0.1
Flexibility	5.2	0.8		3.3	5.8	0.4
EDI						
n = 126		10		1	2	
Age	12.0	0.3		12.8	12.7	0.6
Body Dissatisfaction	0.5	0.5	0.5	1.0	0.0	0.0
Bulimia	0.4	0.8	0.0	0.0	0.0	0.0
Drive for Thinness	1.8	2.3	0.5	0.0	0.0	0.0
Ineffectiveness	3.0	1.2	3.0	3.0	6.0	0.4
Interpersonal Distrust	2.2	2.2	1.5	1.0	7.0	2.3
Introceptive Awareness	1.2	1.9	0.0	2.0	6.0	0.7
Maturity Fears	5.9	3.4	5.5	10.0	10.0	0.9
Perfectionism	6.2	4.3	5.0	10.0	4.0	1.2
SPA						
n = 135		12		1	3	
Age	12.7	0.8		12.8	12.6	0.6
SPA	2.4	0.4		2.0	2.3	0.7

Table 36 (cont'd). Scores on the PSDQ and EDI subscales and for SPA of figure skaters by age group and discipline.

	Discipline								
	13.0-14.9								
Variable	Free			Dance			Pairs		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 37		25			5			7	
Age	14.0	0.7		13.9	0.7		13.8	0.6	
Health	5.0	0.7		4.7	0.4		4.7	0.9	
Coordination	4.8	0.8		3.8	0.8		5.0	1.2	
Physical Activity	5.0	1.0		4.0	0.9		5.3	1.3	
Body Fat	5.1	1.0		5.4	0.8		5.0	1.4	
Sport Competence	5.0	0.8		4.3	1.0		5.0	1.1	
Global Phys. Self-Concept	5.0	0.9		4.8	0.7		5.3	0.9	
Appearance	4.6	0.8		4.4	1.1		5.1	0.8	
Strength	4.7	0.4		3.9	0.8		4.4	1.3	
Endurance	9.0	0.9		8.7	0.6		9.5	0.9	
Self-Esteem	5.4	0.1		5.0	0.4		5.5	0.6	
Flexibility	4.8	0.8		4.2	0.7		3.3	1.1	
EDI									
n = 39		29			5			5	
Age	14.0	0.7		13.9	0.7		13.8	0.6	
Body Dissatisfaction	5.2	6.8	2.0	3.4	4.2	1.0	2.0	1.4	0.0
Bulimia	1.0	1.9	0.0	0.6	1.3	0.0	0.4	0.9	0.0
Drive for Thinness	3.6	4.7	2.0	2.0	2.1	2.0	1.6	0.5	2.0
Ineffectiveness	3.6	2.4	3.0	1.8	1.5	2.0	3.0	1.2	3.0
Interpersonal Distrust	3.4	3.3	3.0	3.8	3.3	3.0	1.2	1.1	1.0
Introceptive Awareness	2.4	2.9	1.0	1.0	1.7	0.0	0.2	0.4	0.0
Maturity Fears	4.9	4.2	4.0	6.6	5.4	5.0	5.6	1.1	5.0
Perfectionism	5.6	3.9	5.0	6.0	1.4	7.0	3.0	0.7	3.0
SPA									
n = 135		28			5			5	
Age	14.6	0.1		14.3	0.9		13.7	0.4	
SPA	2.6	0.7		2.4	0.6		1.9	0.6	

Table 36 (cont'd). Scores on the PSDQ and EDI subscales and for SPA of figure skaters by age group and discipline.

	Discipline								
	15.0-16.9								
Variable	Free			Dance			Pairs		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 38		25			8			5	
Age	15.9	0.6		16.1	0.6		16.2	0.7	
Health	4.8	0.8		4.6	0.4		4.0	0.8	
Coordination	4.9	0.7		4.3	0.7		4.1	0.9	
Physical Activity	5.1	0.9		4.4	1.3		5.3	0.7	
Body Fat	4.3	1.5		4.0	1.7		5.4	1.0	
Sport Competence	4.7	0.9		3.6	0.5		4.8	0.8	
Global Phys. Self-Concept	4.4	1.1		4.0	1.2		5.2	0.8	
Appearance	4.1	1.0		4.0	1.2		4.8	0.7	
Strength	4.5	0.9		4.1	0.9		5.0	1.2	
Endurance	8.8	1.2		8.9	0.9		9.4	0.9	
Self-Esteem	5.1	0.8		5.0	0.7		5.3	0.9	
Flexibility	5.0	0.9		5.1	0.9		4.2	1.3	
EDI									
n = 37		25			8			4	
Age	16.2	0.8		16.4	0.9		16.2	0.7	
Body Dissatisfaction	9.5	8.5	7.0	13.0	9.8	11.5	3.0	3.6	2.0
Bulimia	2.2	4.3	1.0	5.5	5.1	4.0	0.5	1.0	0.0
Drive for Thinness	10.1	7.3	2.5	2.0	4.0	13.0	5.2	5.2	0.0
Ineffectiveness	4.1	3.3	3.0	4.5	2.5	4.0	2.3	0.5	2.0
Interpersonal Distrust	3.4	3.4	2.5	4.3	3.1	4.0	0.5	1.0	0.0
Introceptive Awareness	3.5	4.4	2.0	3.9	3.0	3.5	0.5	0.6	0.5
Maturity Fears	6.3	4.1	5.5	4.5	3.9	3.5	3.0	2.6	3.0
Perfectionism	6.3	4.3	5.0	6.1	1.4	6.5	4.0	4.1	2.5
SPA									
n = 38		25			7			6	
Age	15.8	0.8		16.4	0.9		16.6	0.5	
SPA	2.8	0.8		2.7	1.0		2.8	0.7	

Table 36 (cont'd). Scores on the PSDQ and EDI subscales and for SPA of figure skaters by age group and discipline.

Variable	Discipline								
	17+								
	Free			Dance			Pairs		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 41		21			11			9	
Age	18.4	1.2		19.0	1.7		19.1	0.9	
Health	5.1	0.8		3.9	1.0		3.5	0.7	
Coordination	4.5	0.6		4.1	1.1		5.1	0.3	
Physical Activity	5.1	0.7		5.5	0.6		5.6	0.4	
Body Fat	4.2	1.3		5.2	0.9		3.9	1.6	
Sport Competence	4.9	0.8		4.8	1.1		4.5	0.5	
Global Phys. Self-Concept	4.4	0.9		4.9	0.9		3.6	1.6	
Appearance	4.6	0.5		4.9	0.5		4.0	0.9	
Strength	4.8	0.9		3.9	0.6		4.4	1.0	
Endurance	8.8	0.8		8.8	1.1		9.0	0.9	
Self-Esteem	5.3	0.6		5.2	0.6		5.0	0.8	
Flexibility	4.5	0.9		4.5	0.8		5.1	1.2	
EDI									
n = 37		22			7			8	
Age	18.4	1.2		19.0	1.7		19.1	0.9	
Body Dissatisfaction	8.0	6.0	7.0	7.3	5.1	6.0	12.9	9.5	11.0
Bulimia	1.0	1.7	0.0	4.7	7.4	0.0	2.3	2.7	1.0
Drive for Thinness	5.1	5.8	4.0	11.5	8.4	2.0	6.4	6.4	12.5
Ineffectiveness	2.7	1.8	2.0	3.2	1.5	3.0	4.8	4.2	2.0
Interpersonal Distrust	1.8	2.0	1.0	5.9	5.4	4.0	2.4	2.6	2.0
Introceptive Awareness	1.7	2.9	1.0	5.0	6.9	2.0	6.0	6.0	4.0
Maturity Fears	3.8	3.6	3.0	5.0	5.8	2.0	5.8	2.7	6.0
Perfectionism	5.2	3.8	5.0	8.7	5.5	7.0	6.5	5.4	4.5
SPA									
n = 43		23			12			8	
Age	18.7	1.1		18.9	1.7		19.5	0.6	
SPA	2.8	0.6		2.9	0.5		3.5	1.0	

Table 37. Scores for the PSDQ and EDI subscales and for SPA by discipline.

	Discipline								
Variable	Test			Pre-elite			Elite		
PSDQ	M	SD	Md	M	SD	Md	M	SD	Md
n = 128		84			24			20	
Age	15.4	2.2		16.4	2.2		16.6	2.5	
Health	4.9	0.8		4.4	0.8		4.2	1.0	
Coordination	4.8	0.7		4.2	0.9		4.9	0.8	
Physical Activity	5.0	0.8		4.8	1.1		5.3	0.8	
Body Fat	4.6	1.3		4.9	1.3		4.7	1.4	
Sport Competence	4.9	0.8		4.1	1.0		4.7	0.8	
Global Phys. Self-Concept	4.7	1.0		4.6	1.0		4.5	1.4	
Appearance	4.4	0.8		4.5	1.0		4.5	0.9	
Strength	4.7	0.8		4.1	1.0		4.6	0.6	
Endurance	9.0	1.0		8.9	1.0		9.2	0.8	
Self-Esteem	5.3	0.6		5.1	0.6		5.3	0.8	
Flexibility	4.8	0.9		4.4	1.1		5.0	1.1	
EDI									
n = 126		85			23			18	
Age	15.5	2.3		16.4	2.2		16.6	2.5	
Body Dissatisfaction	1.3	2.7	4.0	3.8	5.8	8.0	1.2	2.1	3.0
Bulimia	3.4	2.5	0.0	3.3	2.1	0.0	3.8	3.1	0.0
Drive for Thinness	2.8	2.9	2.0	4.7	4.2	3.0	1.9	2.3	2.0
Ineffectiveness	2.4	3.4	3.0	3.6	4.8	3.0	3.2	4.8	2.0
Interpersonal Distrust	5.1	4.0	2.0	5.3	4.9	3.0	5.3	3.0	1.0
Introceptive Awareness	5.7	4.0	1.0	7.3	3.7	2.0	4.8	4.2	1.0
Maturity Fears	6.6	7.2	4.0	8.2	7.7	3.0	6.9	8.4	5.5
Perfectionism	4.3	5.4	5.0	6.0	6.5	7.0	6.0	7.6	3.0
SPA									
n = 135		88			25			22	
Age	15.3	2.1		16.8	2.4		16.4	2.2	
SPA	2.7	0.7		2.7	0.7		2.8	1.0	

Table 38. Results of the MANCOVA, with age the covariate, for the PSDQ and EDI subscale scores and of the ANCOVA, with age as the covariate, for SPA scores of figure skaters by discipline.

Variable	Pillai's	df	F
Age Covariate			
PSDQ	0.3	11	3.2*
EDI	0.2	8	3.9*
Discipline			
PSDQ	0.5	22	3.2*
EDI	0.3	16	2.2*

		Discipline					
		1. Free		2. Dance		3. Pairs	
Variable	F(2)	AdjM	SE	AdjM	SE	AdjM	SE
PSDQ (n = 128)		(n = 84)		(n = 24)		(n = 20)	
Health	8.1*	4.9[ab]	0.1	4.4	0.2	4.2	0.2
Coordination	6.0*	4.8[a]	0.1	4.2[c]	0.2	4.9	0.2
Physical Activity	2.5	5.1	0.1	4.7	0.2	5.3	0.2
Body Fat	1.1	4.6	0.1	5.1	0.3	4.7	0.3
Sport Competence	8.4*	4.9[a]	0.1	4.1[c]	0.2	4.8	0.2
Global Phys. Self-Concept	0.2	4.6	0.1	4.7	0.2	4.5	0.2
Appearance	0.2	4.4	0.1	4.6	0.2	4.5	0.2
Strength	5.4*	4.7[a]	0.1	4.1[c]	0.2	4.6	0.2
Endurance	0.8	9.0	0.1	8.9	0.2	9.2	0.2
Self-Esteem	0.4	5.3	0.1	5.2	0.1	5.3	0.1
Flexibility	1.9	4.8	0.1	4.4	0.2	5.0	0.2
EDI (n = 126)		(n = 85)		(n = 23)		(n = 18)	
Body Dissatisfaction	0.4	6.6	0.8	8.2	1.6	6.9	1.8
Bulimia	5.6*	1.3[a]	0.4	3.9	0.7	1.2	0.8
Drive for Thinness	1.1	4.3	0.6	6.0	1.2	6.0	1.4
Ineffectiveness	0.2	3.4	0.3	3.3	0.5	3.8	0.6
Interpersonal Distrust	4.5*	2.8[a]	0.3	4.7[c]	0.7	1.9	0.7
Introceptive Awareness	1.1	2.3	0.4	3.6	0.8	3.2	0.9
Maturity Fears	0.1	5.1	0.4	5.4	0.8	5.3	1.0
Perfectionism	3.1	5.7	0.4	7.3	0.8	4.8	1.0
SPA (n = 135)		(n = 88)		(n = 25)		(n = 22)	
SPA	0.3	2.7	0.1	2.6	0.1	2.7	0.1

* $p < .05$; [a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 39. Distribution of recalled ages at menarche, mean ages at menarche, and results of ANOVA for figure skaters ≥16.0 years by discipline (n = 67).

	Discipline		
	1.Free (n = 38)	2.Dance (n = 17)	3. Pairs (n = 12)
Age Range			
10.00-10.99	0	1	0
11.00-11.99	1	0	0
12.00-12.99	12	4	1
13.00-13.99	15	7	4
14.00-14.99	8	3	0
15.00-15.99	1	0	6
16.00-16.99	1	2	1
M	13.4[a]	13.4[b]	14.5
SD	1.0	1.4	1.3
$F(2) = 4.6$, $p < .01$			

[a]1 differs from 3; [b] 2 differs from 3.

Table 40. Anthropometric characteristics and somatotype of pre- and post-menarcheal figure skaters (n = 159).

Variable	Maturity Status					
	Pre-menarcheal			Post-menarcheal		
n		48			111	
	M	SD	Md	M	SD	Md
Age	13.7	1.3		16.4	2.1	
Weight, kg	42.0	7.0	40.4	54.0	6.8	54.4
Stature, cm	152.4	7.6		160.1	5.8	
BMI, kg/m^2	18.0	1.6	17.7	21.1	2.1	21.1
Sitting Height, cm	78.8	3.4		85.4	3.4	
SH/ST ratio, %	51.7	1.2		53.3	1.2	
Estimated leg length, cm	73.6	4.5		74.6	3.5	
Breadths, cm						
Bicondylar	8.3	0.6		8.8	0.5	
Biepicondylar	5.8	0.4		6.0	0.3	
Circumferences, cm						
Arm, relaxed	21.9	2.0		25.2	2.0	
Arm, flexed	23.4	1.9		26.4	1.9	
Calf	30.6	3.2		33.3	2.2	
Thigh	46.3	3.9		53.2	4.0	
EAMC, cm	20.5	1.9		21.7	1.8	
ECMC, cm	29.7	3.0		30.8	2.2	
Skinfolds, mm						
Triceps	9.5	2.4	8.4	14.0	4.3	13.3
Biceps	4.7	1.3	4.3	5.8	2.4	5.5
Subscapular	6.8	1.7	6.6	10.2	3.5	9.2
Supraspinale	7.6	3.2	6.2	10.0	4.4	9.3
Abdominal	8.1	3.3	7.4	12.0	5.1	11.0
Medial Calf	10.2	3.2	9.2	13.7	4.8	13.4
Sum of Skinfolds, mm	46.9	13.0	43.7	65.6	20.0	63.2
T/E Ratio, mm/mm	0.93	0.19	0.90	0.97	0.23	0.94
Somatotype						
Endomorphy	2.5	0.5		3.6	1.0	
Mesomorphy	3.5	0.8		3.7	0.8	
Ectomorphy	3.8	0.7		2.5	0.9	

Table 41. Results of the ANCOVA, with age as the covariate, for anthropometric characteristics and somatotype[1] of pre- and post-menarcheal figure skaters (n = 159).

		Maturity Status			
Variable		Pre-menarcheal		Post-menarcheal	
n		48		111	
	F(1)	^{Adj}M	SE	^{Adj}M	SE
Weight, kg	16.3*	43.8	1.1	53.2	0.7
Stature, cm	43.2*	153.9	1.1	159.3	0.6
BMI, kg/m^2	51.8*	18.3	0.3	20.9	0.2
Sitting Height, cm	76.5*	79.7	0.6	85.0	0.4
SH/ST ratio, %	38.9*	51.7	0.2	53.4	0.1
Estimated leg length, cm	38.0*	74.3	0.6	74.3	0.4
Breadths, cm					
Bicondylar	10.7*	8.3	0.1	8.7	0.1
Biepicondylar	1.7	5.9	0.1	6.0	0.0
Circumferences, cm					
Arm, relaxed	40.2*	22.3	0.3	25.0	0.2
Arm, flexed	31.9*	23.9	0.3	26.2	0.2
Calf	15.2*	31.0	0.4	33.1	0.3
Thigh	39.0*	47.5	0.6	52.6	0.4
EAMC, cm	2.3	20.9	0.3	21.5	0.2
ECMC, cm	0.9	30.1	0.4	30.6	0.3
Skinfolds, mm					
Triceps	36.4*	9.2	0.6	14.1	0.4
Biceps	17.7*	4.3	0.3	6.0	0.2
Subscapular	24.9*	6.9	0.5	10.1	0.3
Supraspinale	11.0*	7.1	0.7	10.1	0.4
Abdominal	26.8*	7.3	0.8	12.4	0.5
Medial Calf	20.6*	9.7	0.7	13.9	0.5
Sum Skinfolds, mm	33.2*	44.6	3.0	66.7	1.9
T/E Ratio, mm/mm	0.7	0.93	0.03	0.97	0.02
Somatotype					
Endomorphy[1]	19.9*	2.7	0.1	3.5	0.1
Mesomorphy[1]	4.4	3.9	0.1	3.6	0.1
Ectomorphy[1]	6.8*	3.2	0.1	2.8	0.1

* $p < .05$.
[1] Univariate post hoc comparisons adjusted for the univariate post hoc comparison using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 for MANCOVA (Cressie et al., 1986).

Table 42. Scores for the PSDQ and EDI subscales and the SPA of pre- and post-menarcheal figure skaters.

	Maturity Status					
Variable	Pre-menarcheal			Post-menarcheal		
	M	SD	Md	M	SD	Md
PSDQ						
n = 128		38			90	
Age	13.6	1.2		16.7	2.0	
Health	4.9	0.7		4.6	0.9	
Coordination	4.8	1.0		4.7	0.7	
Physical Activity	4.8	0.9		5.1	0.9	
Body Fat	5.4	1.0		4.4	1.3	
Sport Competence	5.0	0.9		4.6	0.9	
Global Phys. Self-Concept	5.1	0.9		4.4	1.1	
Appearance	4.6	0.9		4.4	0.9	
Strength	4.7	0.8		4.5	0.8	
Endurance	9.3	0.8		8.9	1.0	
Self-Esteem	5.4	0.6		5.2	0.7	
Flexibility	4.8	1.1		4.7	0.9	
EDI						
n = 126		38			88	
Age	13.5	1.2		16.7	2.0	
Bulimia	2.2	4.0	0.0	0.6	1.0	0.0
Ineffectiveness	3.6	2.8	3.0	3.1	1.3	0.0
Interpersonal Distrust	3.0	3.4	3.0	2.9	2.7	2.0
Introceptive Awareness	3.2	4.3	0.0	1.2	1.8	2.0
Maturity Fears	5.1	4.1	5.0	5.6	3.7	4.0
Perfectionism	6.1	4.1	5.0	5.4	3.7	5.0
Body Dissatisfaction	9.0	7.6	1.0	1.4	3.2	8.0
Drive for Thinness	6.1	6.3	0.0	1.6	3.0	4.0
SPA						
n = 135		40			95	
Age	13.4	1.2		16.7	2.0	
SPA	2.4	0.6		2.9	0.7	

Table 43. Results of the MANCOVA, with age as the covariate, for the PSDQ and EDI subscales scores, and the ANCOVA for the SPA scores, with age as the covariate, of figure skaters by menarcheal status.

Variable	Pillai's	df	F
Age Covariate			
PSDQ	0.17	11	2.1*
EDI	0.09	8	1.4
Main Effect			
PSDQ	0.15	11	1.9*
EDI	0.15	8	2.6*

		Maturity Status			
Variable		Pre-menarcheal		Post-menarcheal	
	F(1)	Adj M	SE	Adj M	SE
PSDQ (n = 128)		(n = 38)		(n = 90)	
Health	4.6	4.7	0.2	4.7	0.1
Coordination	1.7	4.7	0.2	4.8	0.1
Physical Activity	2.4	4.9	0.2	5.1	0.1
Body Fat	12.3*	5.2	0.2	4.5	0.1
Sport Competence	4.4*	4.9	0.2	4.7	0.1
Global Phys. Self-Concept	7.8*	4.9	0.2	4.5	0.1
Appearance	0.2	4.5	0.2	4.5	0.1
Strength	2.8	4.7	0.2	4.5	0.1
Endurance	2.9*	9.3	0.2	8.9	0.1
Self-Esteem	4.4*	5.4	0.1	5.2	0.1
Flexibility	0.4	4.8	0.2	4.7	0.1
EDI (n = 126)		(n = 38)		(n = 88)	
Body Dissatisfaction	16.6*	1.6	1.4	8.9	0.8
Bulimia	2.4	0.8	0.7	2.1	0.4
Drive for Thinness	7.9*	2.0	1.1	5.9	0.6
Ineffectiveness	2.2	2.7	0.5	3.7	0.3
Interpersonal Distrust	0.2	2.8	0.7	3.1	0.4
Introceptive Awareness	4.2*	1.2	0.8	3.3	0.5
Maturity Fears	1.9	4.7	0.8	5.4	0.4
Perfectionism	0.2	5.5	0.8	6.0	0.5
SPAS (n = 135)		(n = 40)		(n = 95)	
SPA	4.7*	2.5	0.1	2.8	0.1

* p < .05.

Table 44. Results of the ANCOVA of anthropometric characteristics and somatotype[1] of pre-menarcheal skaters by age group (n = 47).

		Age Group								
		11.00 - 11.99			12.00 - 13.99			14.00 - 15.99		
Variable	F(2)	M	SD	Md	M	SD	Md	M	SD	Md
n			8			27			12	
Age		11.8	0.2		13.1	0.4		14.9	0.6	
Weight, kg	1.6	36.6	4.9	38.1	41.3	5.2	40.4	42.3	5.2	42.4
Stature, cm	1.5	147.0	6.5		152.3	6.0		153.1	6.9	
BMI, kg/m^2	0.8	16.9	1.4	17.0	17.6	1.3	17.7	17.9	1.7	18.2
Sitting Height, cm	3.6*	76.9[b]	2.5		78.5	2.4		79.6	4.4	
SH/ST ratio, %	3.5*	52.3[a]	0.7		51.6	1.4		52.0	1.3	
Estimated leg length, cm	1.5	70.2	4.0		73.8	4.5		73.5	3.6	
Breadths, cm										
Bicondylar	1.1	8.2	0.4		8.4	0.4		8.3	0.5	
Biepicondylar	0.4	5.8	0.2		5.8	0.3		5.9	0.4	
Circumferences, cm										
Arm, relaxed	0.1	20.6	0.8		21.5	1.3		22.3	2.1	
Arm, flexed	0.1	22.1	1.0		23.0	1.3		23.9	1.9	
Calf	0.7	29.2	2.3		30.6	3.5		30.9	2.9	
Thigh	0.6	44.2	3.0		45.8	2.2		46.3	3.8	
EAMC, cm	1.2	19.7	1.6		20.3	1.7		21.1	2.0	
ECMC, cm	0.8	29.5	2.2		29.4	3.5		29.6	2.7	

* $p < .05$.

[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 44 (cont'd). Results of the ANCOVA of anthropometric characteristics and somatotype[1] of pre-menarcheal skaters by age group (n = 47).

		Age Group								
		11.00 - 11.99			12.00 - 13.99			14.00 - 15.99		
Variable	F(2)	M	SD	Md	M	SD	Md	M	SD	Md
Skinfolds, mm										
Triceps	0.2	9.3	1.8	8.3	9.3	2.0	8.9	8.6	2.1	8.1
Biceps	1.2	4.2	1.1	4.3	4.8	1.3	4.7	4.2	1.5	3.5
Subscapular	2.1	5.9	1.6	5.2	6.8	1.1	6.7	6.2	1.1	6.6
Supraspinale	0.4	6.4	1.8	6.1	6.8	1.9	6.5	7.5	3.4	6.2
Abdominal	1.9	6.5	2.0	6.6	7.9	2.5	7.4	7.6	2.9	7.7
Medial Calf	0.5	9.4	3.0	9.7	9.7	2.4	8.9	10.3	3.4	9.5
Sum Skinfolds (6)	0.8	41.8	9.5	41.6	45.4	7.7	44.8	44.5	13.0	40.7
T/E Ratio, mm/mm	0.5	0.82	0.11	0.82	0.92	0.18	0.91	0.93	0.17	0.95
Endomorphy[1]	0.2	2.5	0.6		2.5	0.4		2.5	0.7	
Mesomorphy[1]	0.3	3.6	0.6		3.5	0.7		3.5	1.1	
Ectomorphy[1]	0.5	3.9	0.8		3.7	0.7		3.7	0.8	

[1]Univariate post hoc comparisons adjusted for the univariate post hoc comparison using Hotelling's T^2 with a Bonferroni adjusted alpha level of 0.005 for MANCOVA (Cressie et al., 1986).

Table 45. Results of the ANCOVA for the PSDQ and EDI subscales and for the SPAS in pre-menarcheal skaters by age group.

		Age Group								
		11.00-11.99			12.00-13.99			14.00-15.99		
Variable	F(2)	M	SD	Md	M	SD	Md		SD	Md
PSDQ										
N = 37			5			20			12	
Age		11.9	0.6		13.2	0.6		15.5	1.3	
Health	0.2	4.7	1.0		5.1	0.6		5.0	0.7	
Coordination	0.2	5.4	0.4		5.0	0.9		4.5	1.0	
Physical Activity	0.1	5.4	0.6		5.0	1.0		4.7	1.1	
Body Fat	0.3	5.6	0.5		5.6	0.7		5.3	1.0	
Sport Competence	0.5	5.5	0.5		5.0	0.9		5.0	0.8	
Global Phys. Self-Concept	0.1	5.7	0.3		5.2	0.9		4.9	0.7	
Appearance	0.1	4.4	1.3		4.7	0.9		4.3	0.7	
Strength	1.1	5.5	0.4		4.7	0.9		4.8	0.6	
Endurance	1.0	9.8	0.5		9.3	0.9		9.3	0.9	
Self-Esteem	0.1	5.4	0.6		5.0	1.0		4.7	1.1	
Flexibility	1.4	5.4	0.3		4.9	1.1		4.7	1.1	
EDI										
N = 39			8			18			13	
Age		12.6	1.5		13.0	0.4		14.8	0.6	
Body Dissatisfaction	0.4	0.4	0.5	0.0	0.8	1.0	0.0	3.2	5.0	1.5
Bulimia	0.1	0.4	0.9	0.0	0.4	0.9	0.0	1.0	1.1	0.0
Drive for Thinness	0.8	2.6	2.9	3.0	1.1	1.4	0.0	2.8	5.0	0.0
Ineffectiveness	0.4	3.6	0.9	3.0	3.1	1.3	3.0	2.6	1.6	3.0
Interpersonal Distrust	1.4	1.8	1.8	2.0	3.8	3.2	3.0	2.3	1.7	2.5
Introceptive Awareness	0.1	1.6	2.6	0.0	1.2	1.5	1.0	1.2	1.8	0.0
Maturity Fears	0.8	6.2	4.8	5.0	6.5	3.7	5.0	4.9	3.1	4.0
Perfectionism	2.0	9.2	3.9	8.0	4.9	3.7	4.0	5.4	3.3	5.0
SPA										
n = 35			7			20			8	
Age		11.9	0.5		13.1	0.4		14.8	0.6	
SPA	0.7	2.2	0.3		2.2	0.5		2.3	0.5	

* $p < .05$.

Table 46. Results of the ANOVA of anthropometric characteristics and somatotype[1] in post-menarcheal skaters ≥16 by maturational timing (n = 67).

		Maturational Timing					
Variable		Average			Late		
n		45			22		
	F(1)	M	SD	Md	M	SD	Md
Age	8.4*	17.7	1.5		18.7	1.5	
Mean age at menarche	59.6*	13.1	0.6		15.2	0.7	
Weight, kg	1.6	55.3	5.8	54.7	54.6	4.7	53.5
Stature, cm	1.9	161.1	5.4		160.2	4.5	
BMI, kg/m^2	0.5	21.3	1.5	21.1	21.2	1.3	21.0
Sitting Height, cm	4.8*	86.1	3.1		84.8	3.3	
SH/ST ratio, %	3.8*	53.4	1.3		52.9	1.1	
Est. Leg Length, cm	0.0	75.0	3.6		75.4	2.5	
Breadths, cm							
Bicondylar	2.1	8.8	0.4		8.9	0.4	
Biepicondylar	0.3	6.9	0.4		6.0	0.3	
Circumferences, cm							
Arm, relaxed	2.7	25.5	1.6		25.1	1.4	
Arm, flexed	1.2	26.7	1.5		26.6	1.6	
Calf	4.0*	33.9	2.2		33.0	1.6	
Thigh	2.7	54.3	3.2		53.3	2.7	
EAMC, cm	0.6	21.9	1.8		22.2	1.4	
ECMC, cm	0.1	31.0	2.3		31.0	2.1	
Skinfolds, mm							
Triceps	2.3	13.8	3.9	13.5	12.4	3.7	11.8
Biceps	2.8*	5.6	2.2	5.6	4.5	1.1	4.6
Subscapular	3.0*	10.4	3.4	10.1	9.2	2.3	8.7
Supraspinale	2.3	9.8	4.4	9.6	8.6	2.9	8.3
Abdominal	3.6*	12.7	5.5	11.7	10.1	4.1	9.2
Medial Calf	1.1	13.4	3.5	12.5	12.4	3.0	11.0
Sum of Skinfolds, mm	3.8*	65.8	18.0	65.1	57.3	13.0	53.4
T/E Ratio, mm/mm	0.7	1.00	0.26	0.98	0.96	0.23	0.91
Somatotype							
Endomorphy[1]	3.4*	3.7	0.1		3.3	0.2	
Mesomorphy[1]	0.3	3.8	0.1		3.9	0.1	
Ectomorphy[1]	0.9	2.4	0.1		2.4	0.1	

* $p < .05$;

[1] post hoc comparisons adjusted for the univariate post hoc comparison using Hotelling's T^2 with a Bonferroni adjusted alpha level of .05 for MANCOVA (Cressie et al., 1986).

[a] 1 differs from 2; [b] 1 differs from 3; [c] 2 differs from 3.

Table 47. Results of the ANOVA for the PSDQ and EDI subscales and for the SPAS in post-menarcheal skaters ≥16 years classified as average and late maturing.

		Maturational Timing					
		Average			Late		
Variable	F(1)	M	SD	Md	M	SD	Md
PSDQ							
n = 54			37			17	
Age		17.6	1.0		18.8	1.4	
Health	1.3	4.6	1.0		4.2	1.0	
Coordination	2.5*	4.6	0.9		4.9	0.4	
Physical Activity	0.8	5.0	0.9		5.4	0.6	
Body Fat	0.5	4.3	1.4		4.3	1.5	
Sport Competence	0.7	4.4	1.0		4.7	0.7	
Global Phys. Self-Concept	1.1	4.2	1.2		4.3	1.2	
Appearance	1.5	4.4	1.0		4.4	0.8	
Strength	1.5	4.3	0.9		4.6	0.8	
Endurance	2.9*	5.6	1.3		9.3	0.7	
Self-Esteem	2.5*	5.0	0.8		5.3	0.6	
Flexibility	0.2	4.8	1.0		4.6	1.0	
EDI							
n = 52			38			14	
Age		17.7	1.2		18.9	1.3	
Body Dissatisfaction	1.2	10.0	8.0	8.0	7.3	6.6	9.0
Bulimia	1.0	2.1	3.8	0.0	0.9	1.9	0.0
Drive for Thinness	0.2	6.5	6.7	4.0	5.4	6.9	7.0
Ineffectiveness	0.6	3.6	2.8	3.0	2.9	2.6	2.5
Interpersonal Distrust	0.8	2.7	2.7	2.0	2.3	3.4	3.0
Introceptive Awareness	0.1	2.6	3.8	1.0	2.5	3.8	2.0
Maturity Fears	1.7	5.0	4.3	3.0	3.4	2.3	2.5
Perfectionism	0.1	5.8	3.6	5.0	4.4	4.0	5.0
SPA							
n = 60			42			18	
Age		16.4	2.1		17.6	2.0	
SPA	1.7	2.8	0.7		3.1	0.8	

* $p < .05$.

Table 48. Partial correlations holding chronological age constant among physical, physique-related, and select psychological variables in the total sample of figure skaters.

	Psychological Variables									
Physical Variables	10	11	12	13	14	15	16	17	18	19
1. Weight	-0.48[c]	-0.10	-0.35[c]	-0.22[b]	0.54[c]	0.40[c]	0.05	-0.06	0.18[a]	0.31[c]
2. Stature	-0.24[b]	-0.07	-0.19[a]	-0.17[a]	0.40[c]	0.34[c]	0.13	0.01	0.19[a]	0.22[b]
3. SH	-0.26[b]	-0.08	-0.18[a]	-0.19[a]	0.44[c]	0.33[c]	0.10	0.00	0.14	0.22[b]
4. SH/ST Ratio	-0.11	-0.05	-0.04	-0.09	0.22[b]	0.11	-0.02	-0.02	-0.02	0.08
5. Est. Leg Length	-0.14	-0.04	-0.15	-0.10	0.21[b]	0.22[a]	0.12	0.02	0.17	0.13
6. Sum of 6 skinfolds	-0.49[c]	-0.07	-0.24[b]	-0.11	0.40[c]	0.23[c]	-0.09	-0.08	0.03	0.25[b]
7. Endomorphy[1]	-0.32[c]	-0.05	-0.04	-0.01	0.13	0.00	-0.04	-0.01	0.03	-0.08
8. Mesomorphy[1]	0.01	0.00	0.12	0.13	-0.10	0.01	0.01	0.16	0.01	0.10
9. Ectomorphy[1]	0.11	0.01	0.22[b]	0.17	0.19	-0.15	0.00	0.00	-0.01	-0.07

[1] Fourth order correlations, holding age and the other two somatotype components constant.

10 = Body Fat; 11 = Appearance; 12 = Global Physical Self-concept; 13 = Self Esteem; 14 = Body Dissatisfaction; 15 = Drive for Thinness; 16 = Maturity Fears; 17 = Perfectionism; 18 = Bulimia; 19 = SPA.

[a] = $p < .05$; [b] = $p < .01$; [c] = $p < .001$.

Table 49. Second-order partial correlations between height, weight, the sum of 6 skinfolds, and psychological variables controlling for age and the other anthropometric variables, respectively.

Variable	1.	2.	3.
Body Fat	0.20[a]	-0.44[c]	-0.20[a]
Appearance	-0.03	-0.04	-0.06
Global Physical Self-Concept	0.08	-0.26[b]	0.13
Self-Esteem	0.06	-0.20[a]	0.03
Body Dissatisfaction	-0.07	0.34[c]	-0.04
Drive for Thinness	0.02	0.17	-0.10
Maturity Fears	0.07	-0.05	-0.07
Perfectionism	0.12	-0.14	-0.02
Bulimia	0.08	-0.01	-0.15
SPA	-0.08	0.25[b]	0.01

1. Correlation between psychological variables and height, controlling for chronological age and weight.
2. Correlations between psychological variables and weight controlling for age and height.
3. Correlations between psychological variables and the sum of 6 skinfolds controlling for age and weight.

Table 50. Results of the discriminant function analysis for level of competency and discipline in the total sample of figure skaters (n = 114).

Variable	Wilks Lambda	Standard Function	r	F	M	SD	M	SD	M	SD
Level					Test		Pre-elite		Elite	
1. age	0.83	0.40	0.77	15.4	15.4	1.8	15.1	2.2	17.5	2.2
2. endomorphy	0.77	-0.99	0.63	10.7	3.9	1.0	2.8	0.9	3.4	1.0
Discipline					Free		Dance and Pairs			
1. endomorphy	0.96	-0.71	-0.90	18.3	3.6	1.1	2.9	0.8		
2. age	0.90	0.94	0.83	9.6	15.6	2.2	16.5	2.4		

Table 51. The results of the discriminant function analyses for level of competency and discipline in post-menarcheal skaters $\geq$15.0 years and results of the discriminant function analysis for discipline in pre-elite and elite skaters $\geq$ 15.0 years.

Variable	Wilks Lambda	Standard Function	r	F	M	SD	M	SD	M	SD
Level (n = 69)					Test		Pre-elite		Elite	
1. endomorphy	0.76	0.39	-0.75	11.3	4.3	0.7	3.1	1.0	3.5	0.9
2. age	0.65	0.59	0.64	4.8	16.7	1.1	17.1	1.4	18.1	1.7
3. Self-Esteem	0.64	-0.79	0.56	4.6	5.4	0.9	5.9	0.8	6.1	1.7
Discipline										
Total sample (n = 69)					Free		Dance and Pairs			
1. endomorphy	0.92	-0.49	-0.38	17.6	4.0	1.0	3.1	0.7		
2. age	0.83	0.83	0.71	14.5	17.1	1.5	17.8	1.6		
Pre-elite and Elite (n = 50)										
1. endomorphy	0.90	0.91	0.76	5.3	3.6	1.1	3.1	0.7		

Table 52. Correlations between self-concept and psychobiological variables among figure skaters (n = 114).

Psychobiological Variables	SPA A	SPA B	Global Physical Self-Concept A	Global Physical Self-Concept B	Self-Esteem A	Self-Esteem B
Age	0.33^{a}		-0.32^{c}		0.16	
Height	0.32^{c}		-0.32^{c}		-0.23^{b}	
Weight	0.41^{c}		-0.43^{c}		-0.29^{c}	
Endomorphy	0.30^{c}	0.05	-0.20^{a}	-0.06	-0.16	-0.01
Mesomorphy	0.08	-0.15	-0.05	-0.17	0.02	0.14
Ectomorphy	-0.34^{c}	-0.27^{b}	0.32^{c}	0.32^{c}	0.20^{a}	0.20^{a}
Appearance	-0.45^{c}		0.67^{c}		0.65^{c}	
Body Fat	-0.66^{c}		0.73^{c}		0.54^{c}	
Body Dissatisfaction	0.62^{c}		-0.70^{c}		-0.49^{c}	
Drive for Thinness	0.64^{c}		-0.53^{c}		-0.37^{c}	
Perfectionism	0.21^{a}		0.01		-0.01	

A = zero order correlations; B = fourth order correlations, holding age and the other two somatotype components constant.

^{a} $p < .05$, ^{b} $p < .01$, ^{c} $p < .001$.

Table 53. Canonical correlations, canonical loadings, standardized canonical coefficients, percentages of variance, and redundancies between self-concept and psychobiological variables and their corresponding canonical variates.

	First canonical variate		Second canonical variate	
Variables	r	Coefficient	r	Coefficient
Psychobiological Set				
Age	0.39*	0.07	0.22	0.16
Height	0.37*	0.21	0.13	3.08
Weight	0.51*	-0.19	0.19	-4.55
Endomorphy	0.29	-0.23	0.31*	0.70
Mesomorphy	0.09	-0.13	0.09	0.15
Ectomorphy	-0.42*	-0.41	-0.23	-2.22
Appearance	-0.77	-0.45	0.34*	0.35
Body Fat	-0.87*	-0.40	-0.19	0.01
Body Dissatisfaction	0.84*	0.15	0.11	-0.46
Drive for Thinness	0.37	0.15	0.51*	0.88
Perfectionism	0.06	-0.06	0.44*	0.34
Percentage of Variance	0.24		0.02	
Redundancy	0.31*		0.08	
Self-concept Set				
SPA	0.78*	0.32	0.61*	1.18
Global Physical Self-Concept	-0.96*	-0.69	0.23	0.69
Self-Esteem	-0.76*	-0.12	0.31*	0.34
Percentage of Variance	0.70*		0.18	
Redundancy	0.55*		0.04	
Canonical Correlation	0.89*		0.48	

* ≥ 0.30

Table 54. Results of the regression analyses of variables predicting selected EDI subscales in the total sample of figure skaters (n = 114).

Variables	r	R^2	Increment	F	Beta	t
Bulimia						
1. age	0.17	0.03	0.03	4.6[a]	0.02	0.03
2. SPA	0.38	0.15	0.12	13.3[c]	0.34	4.4[c]
3. Health	0.45	0.20	0.05	12.7[c]	-0.37	-3.2[b]
Drive for Thinness						
1. age	0.25	0.06	0.06	10.5[c]	-0.05	0.89
2. Body Fat	0.63	0.40	0.34	57.7[c]	-0.57	-7.1[c]
3. SPA	0.70	0.49	0.09	49.9[c]	0.39	5.6[c]
4. endomorphy	0.72	0.52	0.03	42.1[c]	-0.31	-4.7[c]
5. height	0.74	0.55	0.03	37.9[c]	0.21	3.3[c]
6. Appearance	0.76	0.57	0.02	34.1[c]	0.18	2.7[b]
Body Dissatisfaction						
1. age.	0.30	0.09	0.09	15.4[c]	-0.03	-0.55
2. Body Fat	0.75	0.56	0.47	100.0[c]	-0.55	-5.4[c]
3. Global Physical	0.78	0.60	0.04	78.5[c]	-0.25	-3.5[c]
4. height	0.79	0.63	0.03	65.0[c]	0.17	3.1[b]
5. SPA	0.80	0.65	0.02	55.6[c]	0.17	2.7[b]
Maturity Fears						
1. age	0.17	0.03	0.03	4.7[a]	-0.26	-3.2[c]
2. SPA	0.36	0.13	0.10	11.9[c]	0.38	4.7[c]
3. endomorphy	0.39	0.15	0.02	9.5[c]	-0.16	-2.1[a]
Perfectionism						
1. age	0.05	0.00	0.00	0.4	-0.02	-0.2
2. Health	0.23	0.05	0.05	4.1[a]	-0.21	-2.6[b]
3. SPA	0.29	0.08	0.03	4.7[b]	0.31	3.4[c]
4. Global Physical	0.34	0.12	0.04	5.0[c]	0.22	2.4[a]
5. mesomorphy	0.37	0.14	0.02	4.9[c]	-0.16	-2.0[a]

[a] p<.05, [b] p<.01, [c] p<.001

Table 55. Summary of the results of the hypotheses.

Hypotheses	Support	Comments
1. Figure skaters are smaller i.e., shorter, lighter, smaller in limb circumferences, skeletal breadths, and leaner compared to reference data.	Partially	- except for the sitting height/stature ratio, figure skaters were generally below reference values for U.S. adolescents and young adults
2. Figure skaters are later maturing compared to reference data on non-athletes.	Supported	- median and mean ages at menarche were 14.2 ± 0.5 (status quo) and 13.6 ± 1.3 (recall) years, early maturers were underrepresented
3. Physical self-perceptions decrease with age while social physique anxiety and eating disorder risk increase with age.	Partially	- except for Physical Activity, significant PSDQ correlations were negative, while EDI and SPA correlations were positive
4. Figure skaters will have higher PSDQ scores, and lower SPAS and EDI scores than non-athletes.	Partially	- Skaters reported higher PDSQ scores, lower SPAS scores and lower EDI scores than non-athletes with the exception of Ineffectiveness, Interpersonal Distrust, Introceptive Awareness and Maturity Fears.
5. Elite figure skaters have a unique set of physical and psychological characteristics compared to test skaters.	Partially	- elite skaters were shorter, lighter, smaller (circumferences and breadths) and leaner than test skaters - elite and pre-elite skaters were less endomorphic than test skaters and elite skaters were less ectomorphic than test and pre-elite skaters - pre-elite and elite skaters had higher PSDQ subscale scores than test skaters, test and elite skaters had higher SPA than pre-elite skaters
6. There is a greater proportion of late maturing pre-elite and elite skaters than test skaters.	Not	- there were more average maturing skaters across all three levels of competency - elite skaters had a later mean age at menarche than test skaters, pre-elite skaters did not differ from the other two groups

7. Dancers are older, taller and leaner and have relatively longer legs than either free skaters or pair skaters.	Supported	- dancers were older, taller and leaner, and had relatively longer legs than either free, or pair skaters
8. The more specialized dancers and pair skaters have more favorable self-concept scores, but are at greater risk for eating disorders than free skaters.	Partially	- pair and free skaters reported higher Coordination, Sport Competency and Strength scores than dancers, dancers reported higher Bulimia and Interpersonal Distrust than pair and free skaters
9. There is a greater proportion of late maturing dance and pair skaters than free skaters.	Not	- compared to free skaters, the trend for more late than average maturing pair skaters was evident (58%, residual = 1.9), but this trend was not evident for dancers
10. Pre- and post-menarcheal skaters differ in physical and psychological characteristics.	Supported	- pre-menarcheal skaters were younger, smaller, less endomorphic, more ectomorphic and reported higher PSDQ subscale scores, lower EDI and SPAS scores, fewer met the criteria for eating disorder risk than post-menarcheal skaters.
11. Pre-menarcheal skaters differ in physical and psychological characteristics by age group.	Partially	- there were no significant differences in physical characteristics, younger skater had higher PSDQ scores and lower EDI and SPAS scores than older skaters
12. Late maturing post-menarcheal skaters are shorter, lighter and leaner than earlier maturing post-menarcheal skaters.	Supported	- late maturers had shorter sitting height, longer relative leg length, smaller limb circumferences, thinner skinfolds, and were less endomorphic than average maturers
13. Earlier maturing post-menarcheal skaters will report less favorable psychological characteristics.	Partially	- late maturing skaters had higher PSDQ subscale scores than late maturers, there were no EDI or SPAS differences
14. Selected anthropometric dimensions related to size, proportions and fatness are negatively correlated with selected psychological variables related to perceptions of physical characteristics including: PSDQ subscales (Body Fat, Global Physical Esteem, Appearance, and Esteem), and positively correlated with EDI subscales (Drive for Thinness, Bulimia, Body Dissatisfaction, and Maturity Fears), and SPA	Supported	- controlling for age, weight and sum of 6 skinfolds were positively correlated with EDI subscales and/or SPAS, but negatively correlated with PSDQ subscales, ectomorphy was positively correlated with Global Physical Self-Concept

15. Controlling for age and height, weight and/or sum of 6 skinfolds, variables that are positively correlated during adolescence, reduces the correlations between the physical and psychological variables.	Supported	- most of the correlations were reduced when age and weight, and age and sum of 6 skinfold thicknesses were controlled - most of the correlations remained significant between weight and the psychological variables when age and height were controlled
16. Physical and psychological variables can discriminate level of competency among figure skaters.	Not	- age and endomorphy correctly classified 58% of the skaters by level; no psychological variables classified the skaters
17. Physical and psychological variables can discriminate discipline among figure skaters.	Not	- age and endomorphy correctly classified 66% of the skaters by discipline; endomorphy and age correctly classified 62% of the pre-elite and elite skaters; no psychological variables classified the skaters
18. Level of competency and disciplinary involvement are discriminated by a different set of variables in post-menarcheal figure skaters ≥ 15 years than in the total sample.	Partially	- endomorphy, age and Self-Esteem correctly classified the skaters by level - age and endomorphy correctly classified the skaters by discipline; endomorphy correctly classified 64% of the pre-elite and elite skater; no psychological variables classified the skaters
19. Self-perceptions are predicted by a combination of physical and psychological variables.	Supported	- the combination of height, weight and ectomorphy physical self descriptions and Body Dissatisfaction predicted self-concept (Global Physical Self-Concept, Self-Esteem and SPA)
20. A combination of anthropometric and physique-related variables predict the five eating disorder subscales.	Supported	- each EDI subscale was predicted by a combination of physical and psychological variables and the total variances accounted for ranged from 14 to 65%

Table 56. Means and standard deviations for age, height, weight, and BMI (when reported) of several samples of female figure skaters.

		Age, years		Height, cm		Weight, kg		BMI, kg/m^2	
Sample, reference	n	M	SD	M	SD	M	SD	M	SD
Weaver and Thompson (1981)									
Pre-pubescent	6	13.1	1.2	147.9	9.6	39.0	7.3		
Ross et al. (1977b)									
Canada, novice	9	13.2	1.4	153.5	8.9	42.1	5.7		
Ziegler et al. (1998)									
Competitive	21	13.7	1.4	158.7	7.5	50.3	8.4	19.9	2.4
Faulkner (1976)									
Canada, > 12	21	14.0	1.7	154.1	8.5	45.5	8.2		
Comper (1991)									
Novice	28	14.5		157.6	7.4	48.1	7.6	19.5	3.1
Weaver and Thompson (1981)									
Post-pubescent	8	15.4	1.9	158.5	5.1	51.2	5.6		
Ross et al. (1977b)									
Canada, senior-junior	18	15.7	1.6	156.8	5.2	48.6	6.1		
Present Study	159	15.7	2.4	157.8	7.0	50.0	8.6	20.0	2.5
Brooks-Gunn et al. (1988)									
Elite	25	14-18		160.7	6.0	48.2	5.6		

Table 57. Mean somatotypes of two cross-sectional samples of Canadian and Flemish girls and of figure skaters by age group.

Age Group	Quebec[1] (Bouchard, unpublished)			Belgium[2] (Claessens, unpublished)			Present Study		
	Endo	Meso	Ecto	Endo	Meso	Ecto	Endo	Meso	Ecto
11+	2.8	3.6	3.7	3.0	3.5	3.5	2.5	3.6	3.9
12+	2.7	3.4	3.8	3.2	3.3	3.6	2.9	3.4	3.5
13+	3.3	3.1	3.6	3.5	3.1	3.4	3.1	3.7	3.3
14+	3.6	3.2	3.2	3.8	3.0	3.3	3.4	3.7	2.9
15+	3.6	3.1	3.3	3.9	3.0	3.1	3.2	3.3	3.2
16+	3.7	3.4	2.9	4.0	3.1	2.9	3.7	3.9	3.2
17+	3.6	3.3	3.1	4.0	3.1	2.9	3.9	3.7	2.4
18+	3.8	3.5	2.8	4.1	3.1	2.8	2.7	3.7	2.7
19+							3.5	3.8	2.3

Endo = Endomorphy; Meso = Mesomorphy; Ecto = Ectomorphy.

[1] The Quebec data are from the Quebec Family Study (Malina and Bouchard, unpublished).

[2] The Belgian data are from the Leuven Growth Study of Flemish Girls (A.L. Claessens, personal communication to R.M. Malina).

Table 58. Mean somatotypes of several samples of female figure skaters.

Sample, reference	n	Age		Somatotype endomorphy		Somatotype mesomorphy		Somatotype ectomorphy	
		M	SD	M	SD	M	SD	M	SD
Weaver and Thompson (1981)									
Pre-pubescent	6	13.1	1.2	1.8	0.5	2.8	0.9	3.3	1.0
Ross et al. (1977b)									
Canada, novice	9	13.2	1.4	2.1	0.4	3.7	0.7	3.9	0.7
Faulkner (1976)									
Canada, elite > 12	21	14.0	1.7	2.5	0.7	4.1	0.5	3.2	0.9
Weaver and Thompson (1981)									
Post-pubescent	8	15.4	1.9	2.4	0.4	3.4	0.6	2.8	0.6
Ross et al. (1977b)									
Canada, senior-junior	18	15.7	1.6	2.6	0.7	3.8	0.6	3.0	0.9
Present Study, Total									
Total	159	15.7	2.4	3.3	1.0	3.7	0.8	2.9	1.0
Test	46	15.0	2.1	3.8	1.1	3.7	0.8	2.7	1.1
Pre-elite	66	14.8	2.0	2.9	0.9	3.5	0.9	3.3	1.1
Elite	47	17.7	2.2	2.4	0.9	3.9	0.8	2.3	0.9

Table 59. Status quo and retrospective ages at menarche in figure skaters and athletes in other aesthetic sports.

Sample, reference	Study	n	Chronological Age M	Chronological Age SD	M/Med	SD/SE
Skaters						
Status quo	present study	159			14.2	0.5
retrospective	present study[1]	67	18.1	1.5	13.6	1.2
	Ziegler et al. (1998)[2]	21	13.7	1.4	12.4	1.2
	Brooks-Gunn et al.(1988)[3]	25	15.7	1.2	13.6	1.5
	Ross et al. (1980)[4]	18			14.0	1.3
Gymnasts						
Status quo	Claessens et al. (1992)	168			15.6	2.1
Retrospective					13.2	1.1
Diving						
Status Quo	Malina and Geithner (1993)	107			13.6	1.1
retrospective		28	17-18		14.1	1.3
Ballet						
Status Quo	Gavrilovic (1983)				13.6	
	Gavrilovic and Tokin (1983)				14.1	
retrospective	Warren (1980)	15	15.7	1.2	15.4	
	Brooks-Gunn et al. (1988)	64	15.6	1.3	13.3	1.3

[1] skaters $\geq$ 16.0 years
[2] 17 of the 21 skaters had attained menarche.
[3] The sample contained pre-menarcheal skaters.
[4] 15 of the 18 skaters attained menarche.
[5] 13 of the 15 dancers attained menarche.

APPENDIX A

1. Figure Skating School Consent Form
2. Participant Consent Form

Assent Form

Figure Skating
School Consent Form

Profile of Female Figure Skaters

Dear Figure Skating School,

My name is Eva Vadocz and I am a Doctoral student in the Department of Kinesiology at Michigan State University. As a former figure skater and coach, I am interested in the physical and psychological characteristics of female figure skaters ages 12 and older. I would like to invite figure skaters belonging to your club, to participate in my study. This study is being conducted under the supervision of my advisor, Robert M. Malina Ph.D., and is part of my Ph.D. degree requirements. Additionally, this study has been approved by Michigan State University and is funded by the CFSA.

There is limited information about how junior and senior competitors differ from novice and test-stream competitors, and there is no information comparing the characteristics of singles, dance and pair skaters. Information gathered in this project will provide knowledge about the growth and maturation of skaters, stresses associated with figure skating, and skaters' psychological skills. This information will be beneficial to skaters, parents, coaches and judges at all levels of participation.

All of the measurements will be collected by myself, or two other trained female research assistants. Measurements will include age, height, weight, limb circumferences, diameters, and skinfolds at different sites on the body (back, side, 2-arm, calf, thigh and stomach) to estimate skaters' body composition of muscle and fat. Skinfold thickness is measured by 'pinching' the skin between the fingers and measuring it with calipers. It is not painful, and each measurement will take only a couple of seconds. Measurements will also be taken of the width of skaters' shoulders, hips, knees and elbows.

Skaters will also be asked if they have attained menarche, the first menstruation period. Skaters who have attained menarche, will be asked to try to remember when it began. This information helps pinpoint your physiological maturity status. I understand this is a very personal matter, and precautions will be taken to insure skaters' privacy. In addition, skaters will be requested to fill out some questionnaires concerning their skating history including when, and why they began skating, in what discipline, and at what level they compete. There will also be some questions about skaters' feelings about presenting themselves to others, and some concerning psychological skills.

Participation in this study will take a total of 45 minutes and measurement time will be scheduled at the convenience of your school. I am committed to ensuring the privacy of each skater. In order to collect the necessary measurements, I would like to request a private room (e.g., a dressing room), where measurement equipment can be set up. I would also like to request a time and room for a general information session for parents, coaches and skaters to request their participation.

The information collected in this study will be used on a group basis and treated as confidential. Names will not be associated with the information collected because data sheets will be numerically coded for identification purposes; these codes will be known only to me.

FIGURE SKATING CLUB OFFICIAL:

By signing below, you are agreeing to support our study by allowing us to a) request participation from your skaters, and b) obtain measurements at your facility.

________________________ ________________________

Signature Date

Thank you for your participation. If you have any questions, please feel free to contact me:

Eva Vadocz, (517) 349 - 9962, Email: vadoczev@pilot.msu.edu, Department of Kinesiology, Michigan State University.

You may also contact my supervisor, Dr. Robert M. Malina at (517) 355 - 7620, Email: rmalina@pilot.msu.edu.

Participant Consent Form

Profile of Female Figure Skaters

Dear skaters and parents,

My name is Eva Vadocz and I am a Doctoral student in the Department of Kinesiology at Michigan State University. As a former figure skater and coach, I am interested in learning about the physical and psychological characteristics of competitive female skaters, ages 12 and older by conducting a study. This study is being conducted under the supervision of my advisor, Robert M. Malina Ph.D., and is part of my degree requirements. Additionally, this study has been approved by Michigan State University, your club official, and is funded by the Canadian Figure Skating Association (CFSA).

I would like to invite you and your parents to participate in this study because you are a healthy figure skater competing in CFSA or USFSA sanctioned competitions.

There is limited information about how junior and senior competitors differ from novice and test-stream competitors, and there is no information comparing singles, dance and pair skaters. Information gathered about you and your parents will provide knowledge about the growth and maturation of skaters, stresses associated with competitive figure skating, and skaters' psychological skills. This information will be beneficial to skaters, parents, coaches and judges at all levels of skating participation.

All of the measurements will be collected by myself. or two other trained female research assistants. Measurements will include age, height, weight, limb circumferences, diameters, and skinfolds at 7 different sites on the body (back, side, 2-arm, calf, thigh and stomach) to estimate your body composition of muscle and fat. Skinfold thickness is measured by 'pinching' the skin between the fingers and measuring it with calipers. It is not painful, and each measurement will take only a couple of seconds. Measurements will also be taken of the width of your shoulders, your hips, your knee and your elbow. This part of the study will take approximately 15 minutes and will be scheduled at your convenience. Additionally, as payment for your time, your physical measurements will be available to you upon request at no cost.

You will also be asked if you have attained menarche, your first menstruation period. If you have attained menarche, you will be asked to try to remember when it began. This information helps pinpoint your physiological maturity status. I understand this is a very personal matter, and precautions will be taken to insure your privacy.

In addition, you will be requested to fill out some questionnaires concerning your skating history including when, and why you began skating, in what discipline, and at what level you compete. There will also be some questions concerning your feelings about presenting yourself to others, your eating attitudes, your physical self-description, and some concerning your psychological skills. These questionnaires can be picked up from a central location if you choose to participate by returning the permission forms. Completing the questionnaires will take approximately 40 minutes and can be done on your own time. Please bring the questionnaire pack to the physical testing session.

Your parents will also be requested to answer some questions concerning their height, weight, level of education, occupation and the number of children in your family. If you live away from home, your legal guardian (e.g., coach) can complete this form and your parents may be interviewed by phone at a later date.

All of the information collected in this study will be used on a group basis and treated as confidential. Your name will not be associated with the information because it will be numerically coded for identification purposes; these codes will be known only to me.
If you wish to withdraw from the study at any time, you are free to do so. If you do choose to withdraw, this decision will have no detrimental effect on your relationship with the CFSA/USFSA, your club, the researchers, or Michigan State University.

Your signature, and that of your parent, or legal guardian if your are under the age of 18, indicates that you have decided to participate in this study, and you have read, and understand the information in this consent form.

Thank you for your participation. If you have any questions, please feel free to contact me:

Eva Vadocz, (517) 349 - 9962, Email: vadoczev@pilot.msu.edu, Department of Kinesiology Science, Michigan State University.

You may also contact my supervisor, Dr. Robert M. Malina at (517) 355 - 7620, Email: rmalina@pilot.msu.edu.

Please detach, return to _____________________ and pick up a questionnaire pack. Please fill out these questionnaires and bring them with you on the day of physical measurements. Physical measurements will be collected on _____________________ before, or after your skating session.

PARTICIPANT:

You are making a decision regarding participation. By signing here, you indicate that you have read the above information, and you want to participate in the study.

_______________________________ _______________________________

Signature of Skater Date

Participant Assent Form

Profile of Female Figure Skaters

I agree to participate in a study that will measure my body dimensions, my maturational status and psychological characteristics. I understand that this study has been explained to my mother/father/guardian and that he or she has given permission for me to participate. I understand that I may decide at any time that I do not wish to continue this study and that it will be stopped if I say so.

I understand that measures will be taken of my height, my weight, my bone widths and my limb circumferences, and my body fat will be estimated using calipers to measure skinfolds. I will also be asked some questions about my involvement in figure skating. I understand that this study will take no longer than 30 minutes. In addition, I understand that I will be asked whether or not I have gotten my period yet, and if I have at what age it began. Lastly, I understand that nothing bad will happen to me if I decide to stop my participation in this study at any time.

When I sign my name to this page, I am indicating that this page was read to (or by) me and that I am agreeing to participate in the study. I am indicating that I understand what will be required of me and that I may stop this study at any time.

______________________________ ______________________________

Child's Signature Date

______________________________ ______________________________

Signature of Principal Investigator Date

LEGAL GAURDIAN:

Your signature here indicates that, having read the above information, you have decided to allow your child to participate. You and your child will be offered a copy of this form to keep. If you have allowed your child to participate we ask that you complete the questionnaire for parents attached to this form.

Signature of Parent/Legal Guardian	Date
Signature of Investigator	Date

If you would like a personal report of the measures taken, please provide your address below.

APPENDIX B

1. Demographic Forms

Background Information

Numerical Code ______ Name __________________ Date __________

1) Date of birth ______________
   day/month/year

2) Age of first organized youth sport (skating or other):

Sport _______________ Age _____________
Sport _______________ Age _____________
Sport _______________ Age _____________

3) Are you participating in any other organized sports this year?

A) Yes B) No

If yes, which sport(s)
Sport _________________________
Sport _________________________
Sport _________________________

4) Age at specializing in figure skating? __________

5) Age at specializing in specific skating disciplines?

Discipline ____________ Age _____________
Discipline ____________ Age _____________

6) Please circle those who were important people who influenced your decision to participate in figure skating.

A) Mother
B) Father
C) Coach
D) Friends
E) Other ______________________

7) Skating Club Membership(s)

1)____
2) ____

Which club is your home club? _________________________

8) Please circle the discipline(s) in which you currently compete:

Singles Dance Pairs

At what level do you compete in the above (e.g., novice, junior etc.)?

____

9) Please list your best-ever placing at a competition.

Discipline ____________ Level ____________ Year ______
Discipline ____________ Level ____________ Year ______
Discipline ____________ Level ____________ Year ______

10.) Age at first competition?

Discipline ________________ Year __________ Age __________
Discipline ________________ Year __________ Age __________

11) Number of years competing?

Discipline ____________ Level ____________ Year __________
Discipline ____________ Level ____________ Year __________

12) Total number of competitions in the current competitive year (1997 - 1998) (include those you have already competed in as well as upcoming competitions)?

Discipline ______________ # of Competitions __________
Discipline ______________ # of Competitions __________

13) Total number of competitions in the 1996 - 1997 season ?

Discipline ______________ # of Competitions __________
Discipline ______________ # of Competitions __________

14) Total number of hours training per week?

On Ice __________ Off-ice __________

15) Number of hours training per week for each discipline?

Discipline ________________________ On-Ice hours ________________
Discipline ________________________ On-Ice hours ________________
Discipline ________________________ On-Ice hours ________________

16) Indicate on the line provided: A if you have attempted, and M if you have mastered the following jumps:

Jump	Single	Double	Triple
Axle			
Salchow			
Toe Loop			
Loop			
Flip			
Lutz			

Parental Background Information

1) **Is your child's figure skating expenses funded by an external source (i.e., other than your personal income)?**
Yes _____ **No _____**

2) **Does your child live away from home when training?**
Yes _____ **No _____**

3) **How many children do you have? ______**

4) **What is the birth order of your child participating in this study?**
____

	Mother	**Father**
1. Height		
2. Weight		
3. Highest level of education.		
High school 1-2 years		
high school 3-4 years		
special skills training		
university undergraduate 1-2 years		
university undergraduate 3-4 years		
post graduate 1-2 years		
post graduate 3-4 years		
4. Occupation		
5. Do you currently participate in sport?		
If yes, which sport(s)		
6. Age at first menstrual period		
7. Time of year of first menstrual period (e.g., summer)		
8. Age when first child was born.		

APPENDIX C

1. Anthropometric data form

Anthropometric Measures

Name ____________________ Date ____________________

Date of birth ____________________ Dance Type ______________

Height ____________________ Weight ____________________

Sitting Height ____________________ Leg Length ______________

Arm Span ____________________

Breadths:

Bicondylar ____________________

Biepicondylar ____________________

Circumferences:

Relaxed arm ______________

Flexed arm ______________

Corrected arm ______________

Corrected calf ______________

Skinfolds:

Abdominal ______________ Biceps____________________

Triceps ______________ Subscapular ______________

Supraspanale ______________ Calf ____________________

Menarche:

No ______________ Yes ______________ When? ____________

APPENDIX D

1. Ways of Coping Checklist
2. Physical Self Description Questionnaire
3. Eating Disorder Inventory
4. Social Physique Anxiety Scale

Eating Attitudes Questionnaire

This is a scale which measures a variety of attitudes, feelings, and behaviors. Some of the items relate to food and eating. Others ask you about your feelings about yourself. THERE ARE NO RIGHT OR WROING ANSWERS SO TRY VERY HARD TO BE COMPLETELY HONEST IN YOUR ANSWERS. RESULTS ARE COMPLETELY CONFIDENTIAL. Read each question and circle the column which applies best for you. Please answer each question very carefully. Thank you.

	Always 6	*Usually 5*	*Often 4*	*Sometimes 3*	*Rarely 2*	*Never 1*
1. I eat sweats and carbohydrates without feeling nervous	6	5	4	3	2	1
2. I think that my stomach is too big.	6	5	4	3	2	1
3. I wish that I could return to the security of childhood.	6	5	4	3	2	1
4. I eat when I am upset.	6	5	4	3	2	1
5. I stuff myself with food.	6	5	4	3	2	1
6. I wish that I could be younger.	6	5	4	3	2	1
7. I think about dieting.	6	5	4	3	2	1
8. I get frightened when my feelings are too strong.	6	5	4	3	2	1
9. I think that my thighs are too large.	6	5	4	3	2	1
10. I feel ineffective as a person.	6	5	4	3	2	1
11. I feel extremely guilty after overeating.	6	5	4	3	2	1
12. I think that my stomach is just the right size.	6	5	4	3	2	1
13. Only outstanding performance is good enough in my family.	6	5	4	3	2	1
14. The happiest time in life is when you are a child.	6	5	4	3	2	1
15. I am open about my feelings.	6	5	4	3	2	1
16. I am terrified of gaining weight.	6	5	4	3	2	1
17. I trust others.	6	5	4	3	2	1
18. I feel alone in the world.	6	5	4	3	2	1
19. I feel satisfied with the shape of my body.	6	5	4	3	2	1

	Always	*Usually*	*Often*	*Sometimes*	*Rarely*	*Never*
20. I feel generally in control of things in my life.	6	5	4	3	2	1
21. I get confused about what emotion I am feeling.	6	5	4	3	2	1
22. I would rather be an adult than a child.	6	5	4	3	2	1
23. I can communicate with others easily.	6	5	4	3	2	1
24. I wish I were someone else.	6	5	4	3	2	1
25. I exaggerate or magnify the importance of weight.	6	5	4	3	2	1
26. I can clearly identify what emotion I am feeling.	6	5	4	3	2	1
27. I feel inadequate.	6	5	4	3	2	1
28. I have gone on eating binges where I have felt that I could not stop.	6	5	4	3	2	1
29. As a child, I tried very hard to avoid disappointing my parents and teachers.	6	5	4	3	2	1
30. I have close relationships.	6	5	4	3	2	1
31. I like the shape of my buttocks.	6	5	4	3	2	1
32. I am preoccupied with the desire to be thinner.	6	5	4	3	2	1
33. I don't know what is going on inside me.	6	5	4	3	2	1
34. I have trouble expressing my emotions to others.	6	5	4	3	2	1
35. The demands of adulthood are too great.	6	5	4	3	2	1
36. I hate being less than best at things.	6	5	4	3	2	1
37. I feel secure about myself.	6	5	4	3	2	1
38. I think about bingeing (overeating).	6	5	4	3	2	1
39. I feel happy that I am not a child anymore.	6	5	4	3	2	1
40. I get confused as to whether or not I am hungry.	6	5	4	3	2	1
41. I have a low opinion of myself.	6	5	4	3	2	1
42. I feel that I can achieve my standards.	6	5	4	3	2	1
43. My parents have expected excellence of me.	6	5	4	3	2	1
44. I worry that my feelings will get out of control.	6	5	4	3	2	1
45.						

	Not used		Used somewhat		Used a great deal
49. I make a promise to myself that things will be different next time	0	1	2	3	4
50. I come up with a couple of solutions to the problem	0	1	2	3	4
51. I accept it since nothing could be done	0	1	2	3	4
52. I try to keep my feelings from interfering with other things too much	0	1	2	3	4
53. I wish I could change what had happened or how I felt	0	1	2	3	4
54. I daydream or imagine a better time or place than what I'm in	0	1	2	3	4
55. I wish that the situation would go away or somehow or be over	0	1	2	3	4
56. I have fantasies or wishes about how things may turn out	0	1	2	3	4
57. I pray	0	1	2	3	4
58. I prepare myself for the worst	0	1	2	3	4
59. I go over in my mind what I would say or do	0	1	2	3	4
60. I think about how a person I admire would handle the situation and use that as an example	0	1	2	3	4
61. I try to see things from the other person's point of view	0	1	2	3	4
62. I remind myself how much worse things could be	0	1	2	3	4
63. I mentally picture myself handling the situation better	0	1	2	3	4
64. I remember to put the needs of the team before my own needs	0	1	2	3	4
65. I train or practice harder	0	1	2	3	4
66. I use supporting self-talk to build up confidence	0	1	2	3	4
67. I try to block out negative thoughts	0	1	2	3	4
68. I take it out on other people not involved with the team or sport	0	1	2	3	4

THE PHYSICAL SELF-DESCRIPTION QUESTIONNAIRE (PSDQ)

Name ______________________ Skating Club ______________________

This is a chance to look at yourself. It is NOT a test. There are no right answers and everyone will have different answers. Be sure that your answers show how you feel about yourself. Please do not talk about the answers with anyone else. We will keep your answers private.

The purpose of this study is to see how people describe themselves physically. In the following pages you will be asked to think about yourself physically. For example, how good looking you are, how strong you are, how good you are at sports, whether you exercise regularly, whether you are physically coordinated, whether you get sick very often and so forth. Answer each sentence quickly as you feel now. Please do not leave any sentence blank.

	False ***1***	***Mostly false*** ***2***	***More false than true*** ***3***	***More true than false*** ***4***	***Mostly true*** ***5***	***True*** ***6***
1. When I get sick I feel so bad that I cannot even get out of bed	1	2	3	4	5	6
2. I feel confident when doing coordinated movements	1	2	3	4	5	6
3. Several times a week I exercise or play hard enough to breathe hard (to huff and puff)	1	2	3	4	5	6
4. I am too fat	1	2	3	4	5	6
5. Other people think I am good at sports	1	2	3	4	5	6
6. I am satisfied with the kind of person I am physically	1	2	3	4	5	6
7. I am attractive for my age	1	2	3	4	5	6
8. I am a physically strong person	1	2	3	4	5	6
9. I am quite good a t bending , twisting and turning my body	1	2	3	4	5	6
10. I can run a long way without stopping	1	2	3	4	5	6
11. Overall, most things I do turn out well	1	2	3	4	5	6
12. I usually catch whatever illness (flue, cold etc.) is going around	1	2	3	4	5	6
13. Controlling movements of my body comes easy to me	1	2	3	4	5	6
14. I often do exercise or activities that makes me breathe hard	1	2	3	4	5	6
15. My waist is too large	1	2	3	4	5	6

	False	*Mostly false*	*More false than true*	*More true than false*	*Mostly true*	*True*
16. I am good at most sports	1	2	3	4	5	6
17. Physically I am happy with myself	1	2	3	4	5	6
18. I have a nice looking face	1	2	3	4	5	6
19. I have a loot of power in my body	1	2	3	4	5	6
20. My body is flexible	1	2	3	4	5	6
21 I would do well in a test of physical endurance	1	2	3	4	5	6
22. I don't have much to be proud of	1	2	3	4	5	6
23. I am sick so often that I cannot do all the things I want to do	1	2	3	4	5	6
24. I am good at coordinated movements	1	2	3	4	5	6
25. I get exercise of activity three or four times a week that makes me huff and puff and lasts at least 30 minutes	1	2	3	4	5	6
26. I have too much fat on my body	1	2	3	4	5	6
27. Most sports are easy for me	1	2	3	4	5	6
28. I feel good about the way I look and what I can do physically	1	2	3	4	5	6
29. I'm better looking than mot of my friends	1	2	3	4	5	6
30. I am stronger than most people my age	1	2	3	4	5	6
31. My body is stiff and inflexible	1	2	3	4	5	6
32. I could jog 5 kilometers without stopping	1	2	3	4	5	6
33. I feel that my life is not very useful	1	2	3	4	5	6
34. I hardly ever get sick or ill	1	2	3	4	5	6
35. I can perform movements smoothly in most physical activities	1	2	3	4	5	6
36. I do physically active things (like jogging, dancing, bicycling, aerobics, gym or swimming) at least three times a week	1	2	3	4	5	6
37. I am overweight	1	2	3	4	5	6
38. I have good sport skills	1	2	3	4	5	6
39. Physically I feel good about myself	1	2	3	4	5	6
40. I am ugly	1	2	3	4	5	6
41. I am weak and have no muscles	1	2	3	4	5	6
42. My body parts bend and move in most directions well	1	2	3	4	5	6

	False	Mostly false	More false than true	More true than false	Mostly true	True
43. I think I could run a long way without getting tired	1	2	3	4	5	6
44. Overall, I'm no good	1	2	3	4	5	6
45. I get sick a lot	1	2	3	4	5	6
46. I find my body handles coordinated movements with ease	1	2	3	4	5	6
47. I do lots of sports, dance, gym or other physical activities	1	2	3	4	5	6
48. My stomach is too big	1	2	3	4	5	6
49. I am better at sports than most of my friends	1	2	3	4	5	6
50. I feel good about who I am and what I can do physically	1	2	3	4	5	6
51. I am good looking	1	2	3	4	5	6
52. I would do well in a test of strength	1	2	3	4	5	6
53. I think I am flexible enough for most sports	1	2	3	4	5	6
54. I can be physically active for a long period of time without getting tired	1	2	3	4	5	6
55. Most things I do, I do well	1	2	3	4	5	6
56. When I get sick it takes me a long time to get better	1	2	3	4	5	6
57. I am graceful and coordinated when I do sports and activities	1	2	3	4	5	6
58. I do sports, exercise, dance or other physical activities almost every day.	1	2	3	4	5	6
59. Other people think that I am fat	1	2	3	4	5	6
60. I play sports well	1	2	3	4	5	6
61. I feel good about who I am physically	1	2	3	4	5	6
62. Nobody thinks that I'm good looking	1	2	3	4	5	6
63. I am good at lifting heavy objects	1	2	3	4	5	6
64. I think I would perform well on a test measuring flexibility	1	2	3	4	5	6
65. I am good at endurance activities like distance running, aerobics, bicycling, swimming, or cross-country skiing	1	2	3	4	5	6
66. Overall, I have a lot to be proud of	1	2	3	4	5	6
67. I have to go to the doctor because of illness more than most people my age	1	2	3	4	5	6
68. Over, I'm a failure	1	2	3	4	5	6

	False	Mostly false	More false than true	More true than false	Mostly true	True
69. I usually stay healthy even when y friends get sick	1	2	3	4	5	6
70. Nothing I do ever seems to turn out right	1	2	3	4	5	6

Eating Attitudes Questionnaire

This is a scale which measures a variety of attitudes, feelings, and behaviors. Some of the items relate to food and eating. Others ask you about your feelings about yourself. THERE ARE NO RIGHT OR WROING ANSWERS SO TRY VERY HARD TO BE COMPLETELY HONEST IN YOUR ANSWERS. RESULTS ARE COMPLETELY CONFIDENTIAL. Read each question and circle the column which applies best for you. Please answer each question very carefully. Thank you.

	Always 6	*Usually* 5	*Often* 4	*Sometimes* 3	*Rarely* 2	*Never* 1
1. I eat sweats and carbohydrates without feeling nervous	6	5	4	3	2	1
2. I think that my stomach is too big.	6	5	4	3	2	1
3. I wish that I could return to the security of childhood.	6	5	4	3	2	1
4. I eat when I am upset.	6	5	4	3	2	1
5. I stuff myself with food.	6	5	4	3	2	1
6. I wish that I could be younger.	6	5	4	3	2	1
7. I think about dieting.	6	5	4	3	2	1
8. I get frightened when my feelings are too strong.	6	5	4	3	2	1
9. I think that my thighs are too large.	6	5	4	3	2	1
10. I feel ineffective as a person.	6	5	4	3	2	1
11. I feel extremely guilty after overeating.	6	5	4	3	2	1
12. I think that my stomach is just the right size.	6	5	4	3	2	1
13. Only outstanding performance is good enough in my family.	6	5	4	3	2	1
14. The happiest time in life is when you are a child.	6	5	4	3	2	1
15. I am open about my feelings.	6	5	4	3	2	1
16. I am terrified of gaining weight.	6	5	4	3	2	1
17. I trust others.	6	5	4	3	2	1
18. I feel alone in the world.	6	5	4	3	2	1
19. I feel satisfied with the shape of my body.	6	5	4	3	2	1

	Always	*Usually*	*Often*	*Sometimes*	*Rarely*	*Never*
20. I feel generally in control of things in my life.	6	5	4	3	2	1
21. I get confused about what emotion I am feeling.	6	5	4	3	2	1
22. I would rather be an adult than a child.	6	5	4	3	2	1
23. I can communicate with others easily.	6	5	4	3	2	1
24. I wish I were someone else.	6	5	4	3	2	1
25. I exaggerate or magnify the importance of weight.	6	5	4	3	2	1
26. I can clearly identify what emotion I am feeling.	6	5	4	3	2	1
27. I feel inadequate.	6	5	4	3	2	1
28. I have gone on eating binges where I have felt that I could not stop.	6	5	4	3	2	1
29. As a child, I tried very hard to avoid disappointing my parents and teachers.	6	5	4	3	2	1
30. I have close relationships.	6	5	4	3	2	1
31. I like the shape of my buttocks.	6	5	4	3	2	1
32. I am preoccupied with the desire to be thinner.	6	5	4	3	2	1
33. I don't know what is going on inside me.	6	5	4	3	2	1
34. I have trouble expressing my emotions to others.	6	5	4	3	2	1
35. The demands of adulthood are too great.	6	5	4	3	2	1
36. I hate being less than best at things.	6	5	4	3	2	1
37. I feel secure about myself.	6	5	4	3	2	1
38. I think about bingeing (overeating).	6	5	4	3	2	1
39. I feel happy that I am not a child anymore.	6	5	4	3	2	1
40. I get confused as to whether or not I am hungry.	6	5	4	3	2	1
41. I have a low opinion of myself.	6	5	4	3	2	1
42. I feel that I can achieve my standards.	6	5	4	3	2	1
43. My parents have expected excellence of me.	6	5	4	3	2	1
44. I worry that my feelings will get out of control.	6	5	4	3	2	1

	Always	*Usually*	*Often*	*Sometimes*	*Rarely*	*Never*
45. I think my hips are too big.	6	5	4	3	2	1
46. I eat moderately in front of others and stuff myself when they're gone.	6	5	4	3	2	1
47. I feel bloated after eating a small meal.	6	5	4	3	2	1
48. I feel that people are happiest when they are children.	6	5	4	3	2	1
49. If I gain a pound, I worry that I will keep gaining.	6	5	4	3	2	1
50. I feel that I am a worth-while person.	6	5	4	3	2	1
51. When I am upset, I worry that I will start eating.	6	5	4	3	2	1
52. I feel that I must do things perfectly or not do them at all.	6	5	4	3	2	1
53. I have the thought of trying to vomit in order to lose weight.	6	5	4	3	2	1
54. I need to keep people at a certain distance (feel uncomfortable if someone tries to get too close).	6	5	4	3	2	1
55. I think that my thighs are just the right size.	6	5	4	3	2	1
56. I feel empty inside emotionally.	6	5	4	3	2	1
57. I can talk about personal thought or feelings.	6	5	4	3	2	1
58. The best years of your life are when you become an adult.	6	5	4	3	2	1
59. I think by buttocks are too large.	6	5	4	3	2	1
60. I have feelings I can't quite identify.	6	5	4	3	2	1
61. I eat or drink secretly	6	5	4	3	2	1
62. I think that my hips are just the right size.	6	5	4	3	2	1
63. I have extremely high goals.	6	5	4	3	2	1
64. When I am upset, I worry that I will start eating.	6	5	4	3	2	1

Self-Presentation Questionnaire (SPAS)

Below are some questions about how you feel about your physique (figure). Please check the options as they apply to you. It is important to be as honest as you can. There are no right or wrong answers.

	1 not at all	2 slightly	3 moderately	4 very	5 extremely
1. I am comfortable with the appearance of my physique.					
2. I never worry about wearing clothes that might make me look too thin or overweight.					
3. I wish I wasn't so uptight about my physique/figure.					
4. Sometimes I worry that other people think negatively about my weight or my muscular development.					
5. When I look in the mirror I feel good about my physique.					
6. My physique makes me nervous in certain social settings.					
7. In the presence of others, I worry about my physique.					
8. I am comfortable with how my body appears to others.					
9. It would make me uncomfortable to know others are evaluating my physique.					
10. When it comes to displaying my physique to others, I am a shy person.					
11. I usually feel relaxed when others are looking at my physique.					
12. When I am in a bathing suit, I feel nervous about the shape of my body.					

APPENDIX E

1. University Committee for Research Involving Human Subjects (UCRIHS) Form

MICHIGAN STATE UNIVERSITY

January 20, 1998

TO: Robert M. Malina
213 IM Sports Circle

RE: IRB#: 98-002
TITLE: A PSYCHOBIOLOGICAL PROFILE OF ADOLESCENT COMPETITIVE FIGURE SKATERS: A CONTEXTUAL APPROACH
REVISION REQUESTED: N/A
CATEGORY: 1-B
APPROVAL DATE: 01/19/98

The University Committee on Research Involving Human Subjects'(UCRIHS) review of this project is complete. I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project and any revisions listed above.

RENEWAL: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Investigators planning to continue a project beyond one year must use the green renewal form (enclosed with the original approval letter or when a project is renewed) to seek updated certification. There is a maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB # and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/ CHANGES: Should either of the following arise during the course of the work, investigators must notify UCRIHS promptly: (1) problems (unexpected side effects, complaints, etc.) involving human subjects or (2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of any future help, please do not hesitate to contact us at (517)355-2180 or FAX (517)432-1171.

Sincerely,

David E. Wright, Ph.D.
UCRIHS Chair

DEW:bed

cc: Eva Vadocz

OFFICE OF RESEARCH AND GRADUATE STUDIES

University Committee on Research Involving Human Subjects (UCRIHS)

Michigan State University
246 Administration Building
East Lansing, Michigan 48824-1046

517/355-2180
FAX: 517/432-1171

APPENDIX F

Table 1. Anthropometric characteristics of figure skaters 11.00-11.99 years of age (n = 8).

Table 2. Anthropometric characteristics of figure skaters 12.00-12.99 years of age (n = 12).

Table 3. Anthropometric characteristics of figure skaters 13.00-13.99 years of age (n = 26).

Table 4. Anthropometric characteristics of figure skaters 14.00-14.99 years of age (n = 22).

Table 5. Anthropometric characteristics of figure skaters 15.00-15.99 years of age (n = 24).

Table 6. Anthropometric characteristics of figure skaters 16.00-16.99 years of age (n = 19).

Table 7. Anthropometric characteristics of figure skaters 17.00-17.99 years of age (n = 20).

Table 8. Anthropometric characteristics of figure skaters18.00-18.99 years of age (n = 11).

Table 9. Anthropometric characteristics of figure skaters >19 years of age (n = 17).

Tale 10. Means and standard deviations for subscales of the Physical Self Description questionnaire (PSDQ) for the total sample of figure skaters by age group.

Table 11. Means, standard deviations and number of skaters meeting the criteria for eating disorder risk classification for the Eating Disorder Inventory (EDI) subscale scores for the total sample of figure skaters by age.

Table 12. Means and standard deviations for the Social Physique Anxiety Scale (SPAS) for the total sample of figure skaters by age.

Appendix F - Table 1. Anthropometric characteristics of figure skaters 11.00-11.99 years of age (n = 8).

Variable	M	SD	Median	Min.	Max
Age, yrs.	11.8	0.2		11.5	11.9
Weight, kg	36.6	4.9	38.1	26.8	41.7
Stature, cm	147.0	6.5		135.8	156.8
BMI, kg/m^2	16.9	1.4	17.0	14.5	18.6
Sitting Height, cm	76.8	2.5		72.5	80.3
SH/ST ratio, %	52.3	0.7		51.0	53.0
Est. leg length, cm	70.2	4.0		63.8	76.5
Breadths, cm					
Bicondylar	8.2	0.4		7.6	8.8
Biepicondylar	5.8	0.2		5.5	6.1
Circumferences, cm					
Arm, relaxed	20.6	0.8		19.6	22.2
Arm, flexed	22.0	1.0		21.0	23.8
Calf	29.2	2.4		25.4	32.5
Thigh	44.2	3.0		39.8	48.0
EAMC, cm	19.7	1.4		17.1	21.6
ECMC, cm	29.5	2.2		25.9	33.0
Skinfolds, mm					
Triceps	9.3	1.8	8.3	7.7	12.5
Biceps	4.2	1.1	4.3	2.5	5.7
Subscapular	5.9	1.6	5.2	4.2	8.5
Supraspinale	6.4	1.8	6.1	4.4	9.2
Abdominal	6.5	2.0	6.6	3.9	9.3
Medial Calf	9.4	3.0	9.7	5.2	15.2
Sum of 6 Skinfolds	41.8	9.5	40.0	29.5	56.9
T/E Ratio, mm/mm	0.83	0.11	0.82	0.65	1.27

Appendix F - Table 2. Anthropometric characteristics of figure skaters 12.00-12.99 years of age (n = 12).

Variable	M	SD	Median	Min	Max
Age, yrs	12.6	0.2		12.3	12.9
Weight, kg	41.8	6.3	40.4	35.8	58.5
Stature, cm	151.7	5.6		162.1	165.0
BMI, kg/m^2	18.1	1.9	17.7	16.0	22.3
Sitting Height, cm	77.7	2.6		74.0	84.9
SH/ST ratio, %	51.3	1.4		49.0	55.0
Est. leg length, cm	74.0	4.3		64.1	79.9
Breadths, cm					
Bicondylar	8.2	0.4		7.5	8.9
Biepicondylar	5.7	0.3		5.4	6.4
Circumferences, cm					
Arm, relaxed	22.1	1.7		20.8	26.9
Arm, flexed	23.2	1.7		21.4	27.8
Calf	30.0	1.4		27.5	33.4
Thigh	46.5	3.0		43.8	54.1
EAMC, cm	19.7	1.4		18.3	23.2
ECMC, cm	28.5	1.2		26.2	31.0
Skinfolds, mm					
Triceps	10.1	2.3	10.0	7.8	16.3
Biceps	5.3	1.4	4.9	3.5	7.8
Subscapular	7.7	2.8	7.2	4.5	15.5
Supraspinale	8.1	3.2	7.6	4.7	16.7
Abdominal	9.7	4.1	7.4	5.0	17.7
Medial Calf	10.4	2.2	10.1	7.9	15.3
Sum of 6 Skinfolds	51.3	13.5	46.3	38.0	89.1
T/E Ratio, mm/mm	0.98	0.22	0.94	0.65	1.27

Appendix F - Table 3. Anthropometric characteristics of figure skaters 13.00-13.99 years of age (n = 26).

Variable	M	SD	Median	Min	Max
Age, yrs	13.4	0.3		13.0	13.9
Weight, kg	46.2	7.9	45.8	32.7	60.3
Stature, cm	155.8	6.1		143.2	165.0
BMI, kg/m^2	18.9	2.2	18.5	15.7	24.0
Sitting Height, cm	81.5	3.6		75.5	90.0
SH/ST ratio, %	52.3	1.4		50.0	56.0
Est. leg length, cm	74.3	3.9		66.4	80.9
Breadths, cm					
Bicondylar	8.7	0.5		5.3	9.8
Biepicondylar	5.9	0.3		5.4	6.5
Circumferences, cm					
Arm, relaxed	22.9	2.5		19.1	28.2
Arm, flexed	24.2	2.2		21.3	28.6
Calf	32.1	3.8		27.4	45.2
Thigh	48.5	4.7		41.0	58.4
EAMC, cm	21.2	1.7		17.7	24.2
ECMC, cm	30.7	3.6		24.6	44.1
Skinfolds, mm					
Triceps	11.6	4.0	10.4	6.5	21.3
Biceps	5.3	1.7	5.0	3.1	9.8
Subscapular	8.2	2.7	6.9	5.4	14.9
Supraspinale	8.6	3.7	7.8	3.3	17.9
Abdominal	10.2	4.6	8.3	4.7	24.7
Medial Calf	11.3	4.2	10.4	7.0	21.8
Sum of 6 Skinfolds	55.4	18.5	54.1	32.3	101.4
T/E Ratio, mm/mm	0.94	0.17	0.91	0.51	1.31

Appendix F - Table 4. Anthropometric characteristics of figure skaters 14.00-14.99 years of age (n = 22).

Variable	M	SD	Median	Min	Max
Age, yrs	14.5	0.3		14.0	14.9
Weight, kg	48.4	8.4	48.0	30.6	67.2
Stature, cm	155.2	6.0		145.0	168.1
BMI, kg/m^2	19.6	2.1	19.5	14.9	23.2
Sitting Height, cm	81.6	4.2		75.5	88.5
SH/ST ratio, %	52.5	1.3		50.0	55.0
Est. leg length, cm	73.8	3.1		67.6	79.6
Breadths, cm					
Bicondylar	8.4	0.5		7.5	9.8
Biepicondylar	5.9	0.3		5.1	6.5
Circumferences, cm					
Arm, relaxed	24.0	2.0		18.9	29.6
Arm, flexed	25.4	1.9		20.8	29.3
Calf	31.9	2.4		27.3	36.2
Thigh	49.3	4.5		41.5	56.4
EAMC, cm	21.4	2.3		15.9	26.8
ECMC, cm	29.9	2.6		22.3	33.6
Skinfolds, mm					
Triceps	12.4	4.3	11.0	7.0	22.2
Biceps	5.5	1.9	5.4	2.4	9.8
Subscapular	8.6	2.7	8.5	4.2	17.0
Supraspinale	10.1	4.5	8.9	5.0	21.5
Abdominal	11.6	5.0	9.3	4.6	24.7
Medial Calf	13.7	6.0	12.0	7.0	34.0
Sum of 6 Skinfolds	61.4	20.6	57.6	33.7	104.9
T/E Ratio, mm/mm	0.98	0.18	0.91	0.70	1.45

Appendix F - Table 5. Anthropometric characteristics of figure skaters 15.00-15.99 years of age (n = 24).

Variable	M	SD	Median	Min	Max
Age, yrs	15.4	0.3		15.1	16.9
Weight, kg	51.1	7.7	52.6	33.1	65.8
Stature, cm	161.7	6.7		143.2	169.9
BMI, kg/m^2	19.7	2.1	20.4	15.5	23.4
Sitting Height, cm	87.5	3.9		75.5	93.7
SH/ST ratio, %	54.5	1.3		51.0	58.0
Est. leg length, cm	74.2	4.0		63.9	81.6
Breadths, cm					
Bicondylar	8.5	0.8		6.0	9.5
Biepicondylar	6.0	0.3		4.9	6.5
Circumferences, cm					
Arm, relaxed	24.2	2.2		19.1	27.8
Arm, flexed	25.7	2.0		21.4	33.5
Calf	32.5	2.1		27.4	35.5
Thigh	51.1	4.3		41.0	58.9
EAMC, cm	21.1	1.6		18.2	23.3
ECMC, cm	30.6	2.1		26.0	34.3
Skinfolds, mm					
Triceps	12.8	4.5	11.6	6.0	22.5
Biceps	5.2	1.6	5.5	2.3	10.5
Subscapular	8.8	3.0	8.3	4.6	16.5
Supraspinale	8.8	3.5	8.1	4.4	17.9
Abdominal	9.4	3.9	7.9	4.7	17.8
Medial Calf	12.2	4.1	11.0	5.4	19.5
Sum of 6 Skinfolds	58.0	18.3	56.4	32.3	88.5
T/E Ratio, mm/mm	0.91	0.21	0.89	0.57	1.33

Appendix F - Table 6. Anthropometric characteristics of figure skaters 16.00-16.99 years of age (n = 19).

Variable	M	SD	Median	Min	Max
Age, yrs	16.5	0.3		16.1	16.9
Weight, kg	54.4	7.6	51.7	34.9	72.1
Stature, cm	158.8	6.4		143.0	172.2
BMI, kg/m^2	21.5	2.2	21.5	16.8	24.3
Sitting Height, cm	84.0	3.5		73.5	89.5
SH/ST ratio, %	52.9	1.2		51.0	56.0
Est. leg length, cm	74.8	3.9		67.5	82.7
Breadths, cm					
Bicondylar	8.7	0.5		7.9	9.8
Biepicondylar	5.9	0.4		5.1	6.8
Circumferences, cm					
Arm, relaxed	25.7	2.5		20.2	33.2
Arm, flexed	26.8	2.3		21.4	33.5
Calf	32.7	5.0		14.4	39.7
Thigh	54.2	4.5		41.6	64.0
EAMC, cm	22.3	1.6		18.7	24.7
ECMC, cm	31.1	2.2		27.2	36.7
Skinfolds, mm					
Triceps	13.7	4.9	12.9	6.3	27.0
Biceps	6.3	3.3	5.9	3.4	17.5
Subscapular	11.0	5.0	8.9	5.4	27.2
Supraspinale	10.2	5.2	9.4	4.2	23.9
Abdominal	14.1	6.6	14.2	4.4	30.1
Medial Calf	13.9	5.4	12.3	7.3	31.7
Sum of 6 Skinfolds	69.5	24.5	69.0	31.6	142.9
T/E Ratio, mm/mm	1.04	0.30	0.98	0.67	1.72

Appendix F - Table 7. Anthropometric characteristics of figure skaters 17.00-17.99 years of age (n = 20).

Variable	M	SD	Median	Min	Max
Age, yrs	17.5	0.3		17.0	17.9
Weight, kg	57.3	7.1	57.2	46.2	70.3
Stature, cm	162.9	4.9		151.7	174.2
BMI, kg/m^2	21.5	1.6	21.3	17.9	24.2
Sitting Height, cm	87.7	3.4		82.3	96.3
SH/ST ratio, %	53.8	1.4		51.0	58.0
Est. leg length, cm	75.2	3.2		63.7	79.7
Breadths, cm					
Bicondylar	8.8	0.3		8.1	9.4
Biepicondylar	6.0	0.3		5.3	6.5
Circumferences, cm					
Arm, relaxed	25.9	2.0		21.8	28.6
Arm, flexed	27.0	1.9		22.8	29.8
Calf	34.0	2.4		27.8	38.8
Thigh	54.4	3.3		46.4	60.5
EAMC, cm	21.6	2.1		17.4	24.4
ECMC, cm	30.8	2.9		25.9	35.5
Skinfolds, mm					
Triceps	15.3	4.7	14.8	8.5	26.4
Biceps	6.5	2.4	6.3	3.6	11.3
Subscapular	10.7	3.3	11.9	4.7	18.5
Supraspinale	11.3	4.8	10.3	4.9	24.5
Abdominal	13.3	4.5	14.7	6.2	19.5
Medial Calf	15.6	5.1	14.8	9.7	32.0
Sum of 6 Skinfolds	73.0	21.0	70.9	40.8	124.1
T/E Ratio, mm/mm	0.95	0.19	0.98	0.71	1.30

Appendix F - Table 8. Anthropometric characteristics of figure skaters18.00-18.99 years of age (n = 11).

Variable	M	SD	Median	Min	Max
Age, yrs	18.5	0.2		18.2	18.8
Weight, kg	53.1	4.5	52.6	45.8	59.8
Stature, cm	160.7	4.7		152.7	170.1
BMI, kg/m^2	20.5	1.5	20.7	18.2	22.5
Sitting Height, cm	85.6	2.3		82.8	89.5
SH/ST ratio, %	52.3	0.7		51.7	52.2
Est. leg length, cm	75.1	3.0		69.9	80.6
Breadths, cm					
Bicondylar	8.8	0.3		8.1	9.8
Biepicondylar	6.0	0.3		5.6	6.5
Circumferences, cm					
Arm, relaxed	24.6	1.2		22.9	26.5
Arm, flexed	25.8	1.2		24.1	28.6
Calf	33.3	1.9		31.0	36.5
Thigh	53.3	4.0		48.1	58.8
EAMC, cm	22.2	1.9		17.5	24.5
ECMC, cm	30.3	2.3		26.2	33.2
Skinfolds, mm					
Triceps	10.8	3.2	10.0	7.2	18.0
Biceps	4.0	2.1	3.3	2.4	10.0
Subscapular	8.1	1.4	7.9	5.6	11.2
Supraspinale	6.6	2.2	6.3	4.4	11.2
Abdominal	7.8	1.2	7.4	6.8	10.7
Medial Calf	12.1	3.6	11.3	8.0	17.2
Sum of 6 Skinfolds	50.0	10.8	50.8	37.6	72.7
T/E Ratio, mm/mm	0.85	0.18	1.01	0.56	1.08

Appendix F - Table 9. Anthropometric characteristics of figure skaters ≥19 years of age (n = 17).

Variable	M	SD	Median	Min	Max
Age, yrs	20.2	1.0		19.1	22.3
Weight, kg	54.8	4.5	54.4	46.2	61.6
Stature, cm	160.3	4.9		151.8	168.8
BMI, kg/m^2	21.3	0.9	21.0	19.9	23.0
Sitting Height, cm	85.1	3.4		80.0	91.5
SH/ST ratio, %	53.1	1.1		51.0	55.0
Est. leg length, cm	75.0	2.7		70.4	79.8
Breadths, cm					
Bicondylar	8.8	0.5		7.7	9.8
Biepicondylar	5.9	0.4		5.3	6.6
Circumferences, cm					
Arm, relaxed	25.3	1.2		23.9	27.7
Arm, flexed	26.8	1.4		24.4	30.0
Calf	33.2	1.6		28.6	35.2
Thigh	54.4	2.6		50.8	59.7
EAMC, cm	21.9	1.4		18.4	23.5
ECMC, cm	31.5	1.2		29.4	33.5
Skinfolds, mm					
Triceps	13.1	3.6	13.1	9.4	20.3
Biceps	4.6	1.1	4.3	3.1	6.8
Subscapular	10.6	3.2	9.8	5.6	17.2
Supraspinale	9.6	4.5	7.9	4.7	19.9
Abdominal	10.6	3.7	9.6	5.4	17.5
Medial Calf	11.7	2.2	10.7	9.1	17.8
Sum of 6 Skinfolds	59.6	14.7	56.8	41.1	91.3
T/E Ratio, mm/mm	1.00	0.26	0.92	0.64	1.76

Appendix F - Tale 10. Means and standard deviations for subscales of the Physical Self Description Questionnaire (PSDQ) for the total sample of figure skaters by age group.

		PSDQ Subscales											
Age Group	n	1		2		3		4		5		6	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
11+	4	4.8	1.1	5.3	0.4	5.3	0.6	5.5	0.5	5.4	0.5	M	SD
12+	8	5.1	0.6	5.1	0.6	4.8	1.0	5.5	0.7	4.9	1.1	5.7	0.4
13+	22	4.9	0.7	4.8	0.9	4.8	1.0	5.5	0.8	5.1	0.9	5.0	1.1
14+	17	4.9	0.5	4.6	0.9	5.0	1.1	4.7	1.1	4.8	0.9	5.1	0.8
15+	19	4.7	0.8	4.6	0.8	5.1	0.7	4.7	1.4	4.8	0.7	4.8	0.9
16+	17	4.6	0.7	4.9	0.8	4.7	1.2	4.0	1.7	4.4	0.9	4.7	0.6
17+	18	4.7	0.9	4.5	0.6	5.0	0.6	4.2	1.2	4.4	0.7	3.9	1.4
18+	10	4.3	1.2	4.1	1.2	5.7	0.6	4.9	1.1	4.6	1.6	4.2	1.2
19+	13	4.1	1.1	4.9	0.4	5.4	0.5	4.2	1.6	4.6	0.6	4.9	0.5

		PSDQ Subscales									
Age Group	n	7		8		9		10		11	
		M	SD	M	SD	M	SD	M	SD	M	SD
11+	4	4.2	1.4	5.4	0.4	10.0	0.2	5.9	0.1	5.3	0.3
12+	8	4.8	0.6	4.9	0.7	9.4	0.8	5.6	0.5	5.2	0.8
13+	22	4.8	0.9	4.6	0.9	9.1	0.9	5.4	0.4	4.6	1.1
14+	17	4.4	0.8	4.5	0.7	9.1	0.9	5.2	0.6	4.8	0.8
15+	19	4.3	0.7	4.7	0.7	9.2	1.0	5.3	0.6	4.8	0.9
16+	17	4.0	1.3	4.3	0.8	8.6	1.2	5.0	1.0	4.7	1.0
17+	18	4.6	0.7	4.3	0.8	8.8	0.8	5.1	0.7	4.3	0.9
18+	10	4.7	0.4	4.2	1.3	8.6	1.3	5.3	0.5	5.4	0.7
19+	13	4.4	0.8	4.9	0.5	9.1	0.7	5.3	0.7	4.5	1.0

1 = Health, 2 = Coordination, 3 = Physical Activity, 4 = Body Fat, 5 = Sport Competence, 6 = Global Physical Self-concept, 7 = Appearance, 8 = Strength, 9 = Endurance, 10 = Self Esteem, 11 = Flexibility.

Appendix F - Table 11. Means, standard deviations and number of skaters meeting the criteria for eating disorder risk classification for the Eating Disorder Inventory (EDI) subscale scores for the total sample of figure skaters by age.

		EDI Subscales									
Age Group	n	1		2		3		4		5	
		M	SD	M	SD	SD	M	SD	M	SD	M
11+	4	2.0	2.8	10.3	3.6	0.5	1.0	2.3	1.7	3.6	1.0
12+	7	1.5	2.1	4.4	2.9	0.3	0.7	2.6	2.9	3.0	1.5
13+	21	2.0	3.1	5.9	3.1	1.1	2.3	3.6	3.6	3.2	2.0
14+	18	1.9	2.2	4.6	2.6	0.6	0.8	2.7	2.5	3.3	2.5
15+	20	3.7	4.6	5.7	4.2	1.9	3.6	3.2	3.4	4.2	3.1
16+	17	2.8	3.0	6.4	3.4	3.8	5.3	3.3	3.2	3.8	2.8
17+	17	2.6	2.3	5.9	3.6	1.4	2.4	2.2	2.1	3.2	2.3
18+	9	5.2	7.0	6.8	6.7	4.6	7.2	4.9	6.1	2.4	1.6
19+	13	2.9	4.8	6.3	4.6	1.3	2.3	2.3	2.2	3.8	3.2

		EDI Subscales							
Age Group	n	6		7			8		
		M	SD	M	SD	≥10[a], n	M	SD	≥15[b], n
11+	4	7.0	5.1	0.5	0.6	0	3.3	2.8	0
12+	7	6.4	2.7	0.5	0.5	0	0.6	1.4	0
13+	21	6.4	5.2	2.3	3.7	6	2.3	3.6	1
14+	18	8.3	1.7	7.1	7.4	3	4.1	4.8	1
15+	20	5.6	4.2	9.6	9.1	7	5.7	6.6	3
16+	17	5.6	3.9	9.6	8.5	6	6.8	7.4	4
17+	17	3.5	2.9	10.5	6.1	8	1.4	2.4	3
18+	9	8.0	5.3	6.9	5.5	3	7.6	5.3	1
19+	13	3.3	3.1	7.9	8.3	4	4.9	7.5	2

1 = Introceptive Awareness, 2 = Perfectionism, 3 = Bulimia, 4 = Interpersonal Distrust, 6 = Maturity Fears, 7 = Body Dissatisfaction, 8 = Drive for Thinness, [a] number of skaters reporting Body Dissatisfaction scores >10, [b] number of skaters reporting Drive for Thinness scores >15.

Appendix F - Table 12. Means and standard deviations for the Social Physique Anxiety Scale (SPAS) for the total sample of figure skaters by age.

Age Group	n	M	SD
11+	6	2.5	0.4
12+	13	2.3	0.4
13+	13	2.4	0.7
14+	17	2.7	0.6
15+	19	2.7	0.8
16+	21	2.9	0.8
17+	19	3.0	0.6
18+	10	3.0	0.4
19+	17	3.1	0.9

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