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RELATIONSHIPS AMONG PHYSIQUE, BODY COMPOSITION AND PERFORMANCE CHARACTERISTICS OF PREPROFESSIONAL, COLLEGIATE BALLET DANCERS

by

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THE UNIVERSITY OF UTAH GRADUATE SCHOOL

SUPERVISORY COMMITTEE APPROVAL

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ABSTRACT

The purpose of this study was to examine relationships among stage appearance, technical dance skill, selected anthropometric measures and body composition in preprofessional, collegiate female ballet dancers. The subjects (n = 45) were all full time ballet majors (16-22 years) attending the University of Utah in the Dance Department. The subjects represented a variety of levels of dance proficiency. Stage appearance (STAGE) was determined by the dance faculty using a 5 point Likert scale. A technical dance skill rating (TOTAL) was derived from the sum of seven elements of dance proficiency as assessed by the faculty utilizing seven separate Likert scales. Body composition was determined by hydrostatic weighing. The following anthropometric measures were assessed: height, weight, wrist, forearm, extended biceps, shoulder, chest, waist, hips, thigh, knee, calf, and ankle girths, biacromial and bitrochanteric diameters, triceps skinfold, and waist to tip of coccyx. The zero order correlations revealed significant relationships between TOTAL and weight, wrist, forearm, extended biceps, and waist girths (r = -0.57, -0.49, -0.56, -0.56, -0.53), respectively; and STAGE and weight, percent fat, extended biceps, and waist girths (r = -0.66, -.050, -0.72, -0.69), respectively. Multiple regression analysis revealed

that prediction of STAGE was best accomplished by combining the two girth measures of biceps and hip ($\underline{R}$ = 0.755). Prediction of TOTAL was best achieved with a combination of weight and % fat ($\underline{R}$ = 0.620). Factor analysis revealed that girths of the extremities measured essentially the same underlying factor; the same was revealed for girth measures of the trunk (i.e., shoulder, breast, and waist).

While these results indicate that physique and body composition are related to successful performance and achievement of appearance standards in female ballet dancers, the anthropometric and body composition variables measured in this study do not account for all of the variability in dance performance capabilities or stage appearance. Further research is needed to identify additional factors which might influence success as a ballerina.

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CHAPTER I

INTRODUCTION AND REVIEW OF LITERATURE

The world of stage ballet--to the ardent admirer of this most elegant of the arts, there is only beauty, strength, and grace, the excitement of opening night, and the drama of lifes' fantasies as they unfold across the stage. Perhaps more than any other form of human expression, ballet captures the hearts and imaginations of romantics the world over.

To provide the artistic directors of ballet companies with "pretty ballerinas," untold thousands of aspiring dancers stretch and plié in the more than 30 thousand ballet schools in America, often pushing their growing bodies to and beyond reasonable limits (Gordon, 1983). To many of these girls the experience is short, as the parents redirect their daughters' pursuits, or the children choose other directions. To many others, driven either by a love of ballet or, not uncommonly, the young ballerina's mother, the enchanting world of ballet becomes a way of life, a compulsion.

To those who have spent time behind the scenes there is more, much more than the excitement and rigors of performance: the pain etched on the faces of injured dancers who hide their injury(s) to avoid the inevitable

replacement by any one of dozens of competent ballerinas waiting in the wings (Watts, A., personal communication, April, 1984); the emaciated frames of ballerinas who know only the distorted body imagery of the stage ballerina; the ghostly pale complexion of one who sees only the mirrored walls of the dance studio (Gordon, 1983).

Review of the Literature

The recent interest in ballet dancers by the medical and sports science world has yielded data and information which has made it clear that there exist profound health problems within the glamorous world of ballet, popularly known as "the dance" (Calabrese, 1982; Calabrese, Kirkendall, Floyd, Rapoport, Williams, Weiker & Bergfield, 1983; Sammarco, 1983; Vincent, 1979). It is probable that physical health problems develop primarily as a function of the long hours of dance training in the context of chronic undernutrition that is characteristic of many ballerinas in their constant pursuit of the ultrathin appearance of the classic ballerina. The musculoskeletal problems suffered by virtually every ballet dancer are exacerbated by positional requirements characteristic of classical ballet (e.g., "turnout," point or toe dancing), repetition of jumps, uncontrolled twists and slips, trauma from falls and anatomic malalignment (Bergfield,

1982).

The pursuit of ballet often leads to self-destructive eating behavior (Garner & Garfinkel, 1978), increased risk of disturbance in growth and development (Warren, 1983), dysmenorrhea (Cohen, Kim, May & Ertel, 1982), decreased bone density (Drinkwater, Nilson, Chestnut, Bremner, Shainholts, & Southworth, 1984), malnutrition (Calabrese, 1982) and increased susceptibility to injury and illness (Calabrese & Kirkendall, 1983; Peterson, 1982). These physical forces are further exacerbated in a setting of excessive competition and stress. Calabrese (1982) states that the stress factors may be as great or greater than those of any other sport, due to the pressures of auditioning or maintaining company status, or striving for principal status, as well as the constant threat of being replaced by an understudy in the event of injury. The stress associated with the necessity for constant vigilance of one's weight can become all-consuming and does, in fact, drive some dancers away from their professional aspirations while still in their prime dance years.

Ballet Standards- A Brief History

Traditionally, the subjective judgment of the artistic director has been the primary if not sole basis for the evaluation of aesthetic and technical

standards of professional ballerinas. These standards of appearance and dance skill have evolved over 300-400 years, since the roots of ballet in the 16th century (Calabrese et al., 1983; Sammarco, 1983). The appearance standards, traced by Vincent (1979), appear to be a product of the mid-19th century romantic period of dance. During this period female dancers abandoned the full-figure look utilized to create the earthly, natural characters and themes popular prior to that time. Choreographers began creating mystical roles; depicting such character types as fairies, nymphs, and sylphs, roles requiring exceptional grace and strength, and the wispy figures standard to ballet today (Calabrese & Kirkendall, 1983). As dance became more complex, considerable strength and body control became necessary to perform various movements, not only the great leaps and turns but also the more subtle movements, including point dancing and partnering.

By the late 19th century, rules of order for dance had become very strict. Out of this new discipline arose dancers as both exceptional artists and athletes. As ballet continued to evolve into a disciplined and athletic endeavor, the great choreographers of the 20th century put further demands on their dancers, refining both art and artist alike (Sammarco, 1983). The result of this evolution of ballet and ballerina is a highly trained, ultrathin artist/athlete performing in a highly competitive and demanding arena.

The Ballerina as Athlete and Artist

To further complicate the need to be exceptionally thin is the need to be exceptionally strong. Nicholas (1979) described ballet as a discipline of equal or greater demands than many other sporting activities. Micheli, et al. (1981), in an extensive study of the characteristics of ballerinas in the Boston Ballet, describe professional ballerinas as being comparable in overall fitness to any other world class athlete. Recent work done at this university (White, 1982; Chmelar, personal communication, May,1985) further supports the contention that ballerinas are, as a group, quite fit.

While maintaining the standards of stage appearance and developing and maintaining the fitness of a world class athlete, the ballerinas in a major company's corps de ballet express a level of technical proficiency exceeding that of the most gifted principals of a century ago. It is no wonder, then, that training for this discipline frequently starts by age 6 to 8 and rapidly places increasing demands on the student as she approaches the professional level at age 16 to 22 (Calabrese et al., 1983). For the aspiring-professional ballerina committed to "making the cut" for an opportunity to perform onstage, dance training often becomes an all-consuming endeavor, such that the "increasing demands" referred to above may in fact be a dramatic understatement of the physical and

psychological stress which many of these young dancers endure in the name of performing arts.

Aesthetic Standards of Classical Ballet

In spite of the steady advance in technical standards, the image of the ballerina, which became the standard more than 100 years ago, has changed very little. It is still the "painfully thin" image which the stage ballerina must maintain to satisfy the aesthetic quality that the artistic director has in mind for the company (Calabrese, 1982). In fact, there has been a trend toward increasing leanness in dance in recent years (Calabrese & Kirkendall, 1983).

Image is, understandably, a central concern to any performer who appears in public, but ballet's aesthetic does not value mere thinness, it values excessive thinness (Gordon, 1983). The weight standard which currently dominates the ballet aesthetic is due to the fact that most of the directors of ballet companies and choreographers, who stage ballet works, are of the school which values the traditional sylph-like appearance. Most, in fact, are Russian or European, from a sterner era, and somewhat forbidding (Calabrese & Kirkendall, 1983). Among the many Russians in this country who have influenced and continue to influence the direction and

standards of classical ballet in this country, is one individual who has dictated the fate of thousands of ballet dancers by virtue of his influence within the world of ballet. It was this man, George Balanchine, whose penchant for ultrathinness wrote the script for thousands of pretty ballerinas (Gordon, 1983), who continues, even after his death, to profoundly influence the lives of ballerinas, many of whom will do almost anything to be given an opportunity to perform on stage.

It is likely that the current appearance standards are an extension and exaggeration of the preferences of Balanchine, and other directors, as interpreted by single-minded aspiring ballerinas; rather than a simple product of their wishes. This look, now often referred to as the "Balanchinian aesthetic," can exist and be perpetuated only in a society that idolizes excessiveness. While many may credit Balanchine with the anorectic look of ballerinas, no one individual can dictate taste if that taste does not coincide with that of the culture in which the aesthetic is introduced. Balanchine's predilection would not have been accepted if he lived in a culture that valued a curvaceous female body type as the ideal, but Balanchine lived in America, where society was and remains obsessed with thinness (Calabrese & Kirkendall, 1983; Gordon, 1983). Despite its distortions, the ultrathin look popularized by Balanchine has become the

norm in ballet, a standard which, in its fanaticism, has lead to multiple and profound health problems (Benson, Gillien, Bourdet, & Loosli, 1985).

The sylph-like image in ballet is emphasized due not only to the harshness of stage lighting, which adds 10-20 pounds to a dancer, but also to the benefit of the male dancers who must repeatedly lift the ballerinas. The image of the ballerina has traditionally been created by adherence to goal or contract weights set by artistic directors. Failure to meet these weights, which are often arrived at by the whim of the artistic director rather than any scientific method, frequently leads to loss of the ballerina's job (Calabrese, 1982). These contract weights are intended to produce "the look" synonomous with the ultrathin, sylph-like image characteristic of the modern ballerina.

Recently this ideal appearance standard has been criticized, since efforts to achieve a sylph-like body have resulted in suboptimal diets (Cohen, Potosnak, Frank, & Baker, 1985). Furthermore, achievement of this standard is no guarantee that a dancer's appearance will be acceptable to the artistic director and choreographer, though it is a prerequisite for consideration in most ballet companies. One day that "something special" a choreographer seeks might be stage presence, another day it will be a long neck or perfect feet. This lack of well-defined standards means that

aspiring dancers exist in a kind of "standard limbo," not knowing who will be selected next or for what reasons (Gordon, 1983).

Pursuit of the sylphlike figure of the classic stage ballerina is difficult for those with the genetic predisposition for such a body. For many aspirants, perhaps the majority, visions of sugar plum fairies and success as a stage ballerina are simply illusions. It is a sad reality, perhaps, that regardless of technical virtuosity, a female ballet dancer will never perform if she fails to pass the rigorous and, at times, fickle standards of appearance adhered to in classical ballet (B. Hamblin, personal communication, November, 1985).

Nutrition and Eating Habits

A critical area of interest and concern among many health professionals in ballet is nutrition, that is, the malnutrition that often results from the ballerinas compulsive pursuit of thinness. According to Calabrese (1982), one of the most important medical problems in dance is malnutrition. A study of 92 adolescent ballerinas enrolled in six professional ballet schools demonstrated the incidence of nutritional deficiencies, thereby identifying this population as being at an increased risk of disturbance in growth and development, amenorrhea, decreased bone

density, and anemia (Benson et al., 1985). In a report on the eating habits of professional ballet dancers, Peterson (1982) states that the more common problems in dancers are: binge eating, binge eating followed by forced vomiting, and a sad lack of correct nutritional information. Calabrese et al. (1983) concluded from a nutritional survey that female dancers consume diets low in calories and nutritional density, and there was (in their study) a significant degree of food faddism, and a low awareness of basic principles of nutrition. In an unpublished thesis, White (1982) reported similar conclusions concerning the dietary habits and nutritional status of professional ballerinas in Salt Lake City. Further concerns for the low body weight, eating habits, and eating attitudes of ballerinas have been reported by Gordon (1982) and Vincent (1979).

Several other recent studies of professional ballet dancers (Calabrese & Kirkendall, 1983; Calabrese et al., 1983; Peterson, 1982; Schantz & Astrand, 1984) have characterized nutritional and musculoskeletal patterns which identify this population as being physiologically compromised and therefore at increased risk for injury and illness. It is clear in all these studies that most of the physical (and psychological, as well) problems are related to the female dancers' relentless pursuit of the ultrathin look in the context of overtraining and the unusual positional requirements of female

ballet dancers.

The reasons to be concerned about the nutritional status of ballet dancers are many. Perhaps of greatest concern is the influence of nutritional status on dancers' overriding problem-- injury and healing. A ballerina who trains 30-60 hours per week and is chronically malnourished from 10 to 20 years of self-starvation and poor eating habits (from pursuit of excessive thinness), undoubtedly suffers from a compromised resistance to injury and a compromised healing capacity (Ruberg et al., 1984). Furthermore, nutritional deficiencies increase susceptibility to infection, enhance severity and prolong the duration of illness (Chandra & Tejpar, 1982), a major concern of dancer and choreographer alike.

Both Benson et al. (1985) and White (1982) have reported specific deficiencies in the diets of female ballet dancers which would, theoretically, compromise the integrity of bone and support tissue. There is further concern for the maintenance of bone tissue in many female dancers with delayed menarche and/or dysmenorrhea. The problem seems to stem from the complex relationship between menstrual function, ovarian hormones, and bone homeostasis.

Menstrual Function, Hormones and Bone Metabolism

According to several investigators (Christiansen & Mazess, as reported by Lutter, 1983; Lindsay, Hart, MacLean, Clark, Kraszewski, & Garwood, 1978; Nordin, Aaron, Speed, & Crilly, 1981; Underwood & VanWyk, 1981), the estrogen hormones serve to protect bone by reducing the rate of destruction. Estrogens are known to decrease with cessation or disruption of menstruation (Cann, as reported by González, 1982; Warren, Brooks-Gunn, Hamilton, Warren & Hamilton, 1986), as occurs in many ballerinas. Cann suggests that an estrone (an estrogen hormone) deficit, perhaps in concert with deficiencies of other ovarian hormones, may be responsible for premature bone loss in dysmenorrheic runners.

A high incidence of secondary amenorrhea and irregular menstrual periods has been reported among ballet dancers (Cohen et al., 1982; Warren, 1983), as well as runners, figure skaters, gymnasts, cyclists, body builders, swimmers, and other athletes (Malina et al., 1978; Drinkwater et al., 1981). A high incidence of delayed menarche has also been reported among dancers (Cohen et al., 1982; Warren, 1983; Warren et al., 1986). Delayed menarche, as well as dysmenorrhea, has been reported (Warren et al., 1986) to be correlated with an increased incidence of scoliosis (excessive spinal curvature) and stress fractures. It has been proposed by Warren et al.

(1986), that scoliosis and stress fractures, as were seen in their study, are manifestations of inadequate calcification and apposition (layering) of bone. The result, in a dancer at puberty, is a bone density that is lower than normal, such that loss of bone at even a normal rate could result in a mechanically incompetent skeleton and fractures. Stress fractures also predispose dancers to more debilatating injuries (Warren et al., 1986), a great concern of virtually every dancer.

Menstrual dysfunction associated with lean athletes, often in the context of excessive stress, is frequently referred to as exercise-induced or athletic dysmenorrhea. Frisch and Revelle (1971) suggested that it is simple weight loss or gain which accounts for cessation or resumption of menses, since loss or gain of weight usually parallels fat loss or gain and fat makes estrogen. This theory has since been dismissed by several investigators (Drinkwater, Shangold, Loucks, Wilmore & Foreman, 1981; Loucks & Horvath, 1986) as oversimplified. Foreman (Drinkwater et al., 1981) suggests that psychological stress often plays the starring role in the dysmenorrhea picture. D.V. Harris (personal communication, January 7, 1987), reported the results of a study of nearly 200 female athletes with menstrual problems. She states that the menstrual problems were correlated with one of three kinds of stress. The first is the physical

stress of a significant weight loss during a short period of time. The second is severe psychological trauma resulting in amenorrhea. The third was extremely demanding training. Loucks and Horvath (1986), in a recent review of the subject, suggest that while the mechanisms are as yet ill-defined, athletic amenorrhea is likely due to some combination of body composition, training regimen, reproductive maturity, sport specificity, diet, and psychological stress.

Though the many variables involved in this exercise-dysmenorrhea-hormone-bone metabolism picture have yet to be worked out, there is enough evidence to suggest that dancers with delayed menarche or dysmenorrhea are at risk for bone loss. Given the exceptionally rigorous demands on the boney structure of the female dancer and the critical importance of resistance to and recovery from injury, this issue of menstrual function and integrity of bone mass appears to be critical to the professional or aspiring professional ballerina.

Eating Disorders

The incidence of eating disorders among professional ballet dancers, while still open to question, appears to be much higher than the general population. According to Garner and Garfinkel (1978), one in 20, or 100

times that of the general population, express some degree of eating disorder. Hamilton, Brooks-Gunn and Warren (1985) reported an incidence of 22% anorexia nervosa in ballet dancers.

To achieve "the look," most female dancers survive on very low calorie diets. In a survey conducted by Druss (1979), the average daily intake was 1,000 kcalories. White (1982) reported an average total intake of 1280 kcalories; Benson et al. (1985) reported that 29.8% of their population of adolescent ballerinas consumed less than 1500 kcalories. Most dancers, according to Peterson (1982), practice starvation to meet dance expectations. Intentional dehydration, laxative abuse, self-induced vomiting, and fasting are all common methods of weight control (Maloney, 1983). For a ballerina who trains many hours per week in preparation for performing opportunities, undernutrition at the level being documented in ballerinas is tantamount to certain injury and/or ill health.

Though ballerinas who come from tall, lean families who have eaten sparsely but well and who have incorporated aerobic activity into their dance lifestyles may not have to worry about maintaining the sylph-like image of the dancer, for every one of these there are "barres full" of normally developing females who compromise their health by trying to achieve such a look (Peterson, 1982). The extent to which many aspiring

and professional dancers push the limits of their bodies in order to obtain the ideal body image is illustrated by the following:

> She had vomited after every meal as long as she had been with the company. She was depressed, anxious, and highly critical of any comments regarding diet. She was on a self destruction pattern without control. She said that if she did not vomit she would gain weight, the other dancers would think she was fat, and she would lose her roles (Peterson, 1982).

A New York physician who works with ballet dancers says- " '...you tell a kid to take a pill three times a day with meals, and the kid says she doesn't eat three meals a day. She doesn't eat breakfast; she doesn't eat. Period' " (Gordon, 1983).

While it appears that the dancers at this institution are better educated and more aware of nutritional principles, as well as committed to their practice, than dancers involved with ballet conservatories in many cities (B. Hamblin, personal communication, November, 1985), it is reasonable to assume that there are individuals within this population who suffer from eating disorders. In fact, there have been five female dancers identified within the department with bulemic habits. Suffice it to say that weight, weight control, and appearance are major issues with the professional ballerina and of major concern to the health professional involved with "the dance."

Given the currently invariate nature of the gold standard for the stage appearance of ballerinas (i.e., physical appearance), a health professional can only hope to provide sound guidance in the ballerinas' pursuit of the sylph-like image so that she may pursue her goal without unduly jeopardizing her health or performance. As expressed by a member of the faculty in the University of Utah Ballet Department- "The old traditions of ballet that have stood the test of time die hard, and the best one can hope for if there is conflict between art and science is a compromise" (B. Hamblin, personal communication, November, 1985).

Sport Profiling- The Science of Anthropometry

Sport profiling, the application of the science of anthropometry, is defined by Nicholas (1984) as the gathering of information about the physical attributes of athletes, and can involve many science/medical specialties. The values of profiling can be many and diverse, depending on the needs and interests of the investigators and parties involved. In a general sense, profiling permits a better understanding of the interrelationships between the various systems of the body. It also provides a means to determine the relative contributions of physiologic, neuromuscular, psychometric, and environmental factors in the performance

of sports (Nicholas & Hershman, 1984). Some of the more specific applications of profiling include efforts to minimize injury and enhance performance through characterization and development of specific performance attributes.

The recent development and application of the science of anthropometry by sport scientists has permitted the creation of sports profiles which describe the qualities and characteristics of athletes in various sports. For example, profiling is being used extensively in professional football to predict players at high risk for injuries, those who might improve their performance by gaining or losing weight, and to optimize performance characteristics (Gleim, 1984). Detailed profiles have also been established for athletes in: track and field, gymnastics, baseball, basketball, soccer, wrestling, hockey, tennis, racquetball, racing, swimming, volleyball and dance (Coleman, 1984). These profiles, which include anthropometric, biomechanical, physiological, neuromuscular, nutritional, and psychometric information, are of value for a multitude of reasons. For the athlete or dancer, they represent standards against which she or he can compare herself or himself, as a basis of comparison of her or his own fitness and as a guide to training and performance (Micheli et al., 1984). Quantitative evaluation of physique can help both the athlete or

dancer, as well as the coach or teacher, attain goals required in different phases of physical conditioning and training regimens and evaluate current training practices to assess conditioning status and bring physical appearance "in line" with norm referenced physique values (Katch & Katch, 1984).

For the coach or teacher, profiling helps identify those with exceptional potential, those with little potential and those in-between; as well as indicating specific areas of training to be emphasized. Further, profiling can reveal specific characteristics related to performance, injury, illness, and physical appearance. One of the most valuable profiling tools for the dancer and health professional involved in dance is body composition assessment; the standard being hydrostatic weighing. Evaluation of body composition permits quantification of the major structural components of the body-- muscle, bone, and fat; which has many applications. One of these is the determination of minimal standards for leanness in the ballerina, since there seems to be a biologically lower limit beyond which a person's body weight cannot be reduced without impairing health status, a major concern among elite level ballerinas. Another, perhaps less obvious benefit of profiling for the coach or teacher, is freeing the coach from the task of making decisions about body composition and training, then having to

enforce individual interventions. Instead, the coach can act in the capacity of facilitator, helping athletes to achieve personal goals (Katch & Katch, 1984).

For the sport scientist, profiling permits a better understanding of the nature of the sport and the participants. For the health care professional, they represent 'normal' values which can be used to identify deficiencies, prescribe corrective activities and evaluate rehabilitative procedures (Coleman, 1984). At a very practical level, profiles can be used to guide individuals to participate only at levels of skill in which they can meet the imposed demands (Nicholas, 1984). Often times, an athlete or dancer participating in an athletic endeavor with more imposed demands than what she or he can withstand ends up injured. There is, perhaps, nothing more devastating to the career of an athlete or dancer, at any level, than an injury that restricts or eliminates such an individual from her or his pursuits (Hershman, 1984). In the case of many ballerinas, dance is not only her compulsion, it is her entire life.

With the immense growth in popularity of ballet in recent years there has been a concomitant increase in injuries associated with dance. The majority of these injuries, according to Micheli et al. (1984) are overuse injuries, from dance classes and performances. Must injuries continue to

mar dancers' goals? While it is probable that some injuries are unavoidable, given the nature of ballet, other injuries and conditions may be entirely preventable. In dance, the majority of injuries are overuse syndromes which, in many cases, are preventable. Many medical professionals in the areas of sports orthopedics, kinesiology, exercise physiology and other related sciences believe that not only are many sports-related injuries preventable, but the means to prevent them is sports profiling, when applied, analyzed and interpreted by appropriate sport scientists and medical professionals (Hershman, 1984).

Though still in its infancy, performer profiling is already being implemented in many professional and amateur sports arenas to improve performance, help prevent injury and to identify specific characteristics relevant to specific athletic endeavors. While the immediate goal of this project was to provide information which would identify specific characteristics pertinent to acceptance into and successful performance in ballet, secondary goals include the reduction of suffering among aspiring ballerinas and the improvement of performance.

Theoretically, profiling could be applied in ballet to predict those individuals who are most likely, and unlikely, to succeed. This approach is being applied to the selection of ballet dancers in the Soviet Union (B.

Hamblin, personal communication, November, 1985). Furthermore, profiling is reaching the point where prediction of success or failure in a variety of sports is possible (Goldberg & Boiardo, 1984). Prudent application of profiling, after the requisite generation of a sound data base, may provide a means to reduce some of the unnecessary suffering so prevalent in ballet today. As the sophistication, validity and precision of these evaluatory techniques increases, it becomes increasingly plausible to utilize such techniques in ballet to predict specified outcomes and perhaps help ballerinas and ballet teachers achieve their goals.

While making great strides in the prediction of motor performance and identification of those at risk for injury, sports profiling has provided little development of anthropometry for the purpose of predicting acceptability of physical appearance. This may be due to the fact that physical appearance is of concern in only a few activities that are athletic in nature (e.g., dance, gymnastics & figure skating). Among these endeavors, only ballet is so dramatically influenced by appearance standards.

As in any endeavor, there is most certainly a genetic component which influences who might and who will not excel in this multifaceted discipline. Unlike the development of technical skills and stage presence, it is probable that physical appearance (i.e., gross morphological structure), at least at its

limits is, to a great extent, dictated by the genetic predispositions of the dancer. At a practical level this means that an aspiring ballerina with a genetic predisposition inappropriate for classical stage ballet will struggle to "make weight" and, even if she makes it into a ballet company she will likely end up practicing starvation throughout her career in order to maintain her performing weight (i.e., appearance). The implications for a young, aspiring dancer suggest that many will practice chronic self-starvation and/or other eating disorder behaviors in an effort to achieve and maintain the Balanchine aesthetic, risking malnutrition, delayed menarche and/or dysmenorrhea, with the consequences of biochemical deficiencies, impaired resistance to injury and illness, compromised bone density and, in the case of delayed menarche, delayed closing of epithyseal plates.

While there are numerous potential benefits for the dancer and dance professional from the judicious application of profiling to dancers, there are two potential adverse effects identified by Goldberg and Boiardo (1984), if applied to aspiring dancers. One, children must not be pushed into pursuing dance beyond their interest and willingness just because their profile identifies them as possessing the characteristics highly associated with success. Conversely, children with profiles associated with a low chance of success cannot be excluded from participating, unless well-

documented evidence demonstrates an unacceptable risk.

Summary

The image of the ballet dancer as artist, at least in the sports science/ medicine world, is rapidly changing with the realization that exceptional dancers are first exceptional athletes and, as such, are prey to many of the same physical problems of other highly trained athletes, in addition to problems unique to the dancer. Of primary concern are disturbances in growth and development, increased susceptibility to injury and illness, dysmenorrhea with its various disruptions of hormone metabolism, and the high levels of stress related to auditions and performing, and achievement and maintenance of weight standards. It is the belief of many sport scientists and medical professionals that profiling offers a powerful means of better understanding athletes and their needs, thereby permitting reduction of such problems and better service of their needs.

The fruitful application of profiling in sports first requires the development of a valid data base, to permit clarification of those characteristics related to success (and probable failure) in a given athletic endeavor. Such a data base can be developed to permit not only prediction of success but also the elucidation of strategies for improving performance

and reducing problems (e.g., injuries). It was the intent of this study to collect such a data base to permit development of profiles and models which would enable the Ballet Department to assist student dancers in achieving their dance-related goals, while also attending to the responsibilities of this ballet faculty.

Justification

There has been no reported research which has sought to examine which specific physique characteristics of the sylph-like body type are associated with success as a female ballet dancer. Therefore the purpose of this project was to investigate the relationships among stage appearance, technical dance skills and selected anthropometric measures in an effort to address this issue. In essence, this study was an effort to profile this population of student ballerinas, then determine if there were any significant correlations between the anthropometric characteristics and dance skills and/or physical appearance.

If significant relationships do exist in this population then, with the development of a larger data base and refinement of the profile, profiling could effectively be used to identify dancers with the physique characteristics associated with success, and failure, as a ballerina. Such

information could be useful not only in guiding aspiring young ballet dancers and their teachers in training and dietary strategies, but also in honing the physical qualities of the professional through the application of the sports sciences.

It is of paramount importance that health professionals learn to analyze and interpret the information obtained from profiling in order to minimize disability in sports (Nicholas & Hershman, 1984). Disability in sports includes, in addition to injuries, reductions in general health, performance and enjoyment. Katch and Katch (1984) believe that profiling, when combined with the capabilities of the computer, is the wave of the future in the management of athletes.

In order for the ballet faculty at the University of Utah to make informed decisions concerning stage appearance (e.g., who must lose, or gain, how much weight to achieve an acceptable appearance) it has been obvious to a concerned few in the Ballet Department of the University of Utah that the traditional weigh-in is grossly inadequate for the successful and healthful management of weight and stage appearance. Further, it was believed that by quantifying the physical characteristics of the female ballet dancers, many of the physical and physiological problems associated with participation in ballet could, theoretically, be addressed scientifically

and perhaps improved.

In addition to the anthropometric measures taken, body composition assessments via hydrostatic weighing, height, weight and age, and a few other physical measurements were obtained. Together these comprised the predictor variables. The criterion variables, stage appearance and a total of technical ballet dance skills, were assessed and reported by the faculty of the Ballet Department at the University of Utah.

Statement of the Problem

The primary purpose of the study was to profile the physical characteristics of ballet dancers enrolled in the Dance Department at the University of Utah in order to provide the faculty with information to assist in the successful and healthful management of weight and appearance standards.

The secondary purpose of the study was, through physical profiling and statistical analyses, to explore relationships between the physical and physiological characteristics of the dancers and their technical dance skills and stage (physical) appearance in order to develop means with which to predict the probability of success in ballet at this institution. In order to address these questions, a series of body girths, bone diameters and triceps

skinfold were measured, body composition assessed, and height, weight and age recorded. These predictor variables were correlated with technical dance skills and physical appearance, the criterion variables.

Research Questions

The research questions are as follows, in order of their concern.

1. What are the physical characteristics of this population of female ballet dancers?

2. Do any of the anthropometric variables, or combinations thereof, permit prediction of the success of these dancers in terms of achievement of technical dance skills or stage appearance? A subproblem within this larger problem is whether there are distinct differences in such patterns between the four levels of dance proficiency established at the University of Utah?

The immediate goal of this study is to provide data and analyses which address these questions. The long term goal is to provide data and perhaps a working model for the prediction of success in ballet in order to assist both the dancer and dance professional pursue and, it is hoped, achieve reasonable dance-related goals.

CHAPTER II

PROCEDURES

Prior to the initiation of this study, approval was obtained from the University of Utah Review Committee for Research with Human Subjects (Health Sciences). As required by the Review Committee, an informed consent (Appendix A) was obtained, in writing, from all participating subjects (American College of Sports Medicine, 1980). All testing procedures were thoroughly explained to each subject. The subjects were also informed that they could withdraw from the study at any time without prejudice.

Subject Selection

Subjects (n = 45) were selected from the population of matriculated female dancers in the Ballet Department at the University of Utah (N = 70). All subjects were recruited on a volunteer basis. The subjects ranged in age from 16.3 to 21.8 years, all were Caucasian, with no apparent medical problems which might be influenced by participation in the study. No effort was made to restrict the diet or fluid intake of the subjects but they were encouraged to abstain from eating for 4 hours before the anthropometric

measurements were taken and to drink plenty of fluids during the 24 hours before underwater weighing.

To ensure the representativeness of the subject pool (i.e., all female dancers in the Ballet Department at the University of Utah) of those included in the study, the age, height and weights of the subject pool were determined and compared to the study population. The mean age, height and weight of the subjects included in the study as follows: 19.1 years, 166.3 cm (65.5 in.), 54.2 kg (119.3 lbs). The mean age, height and weight for the subject pool-- 19.4 years, 165.8 cm (65.3 in.), 54.9 kg (120.8 lbs), are very similar.

Sequence of Events

Subjects received a battery of standard anthropometric tests as well as body composition assessment by underwater weighing. In addition, the subjective measures, stage appearance and technical dance skills, were assessed on each subject by a member of the ballet department faculty. Prior to testing, subjects were familiarized with the equipment to be utilized in the anthropometric measures. All of the anthropometric measures were collected at poolside in the natatorium at the University of Utah, while the actual underwater weighing was conducted in the

natatorium's diving pool. The subjects were in their swimsuits for all measurements and all the anthropometric measures were collected between 6:00 and 8:00 pm during the week or Sunday afternoons between 1:00 and 5:00 pm. The data collection period was from October, 1984 to March, 1985, with the exception of 2 subjects who were measured and assessed in May of 1984.

Dancers were instructed to report to the pool in their bathing suits, at which time consent forms were completed and height, weight, and age information was collected. Prior to entering the pool for hydrostatic weighing the body girths, bone diameters, and triceps skinfold measurements were taken. The dancers were then requested to enter the water for the hydrostatic weighing.

All assessments of stage appearance and technical dance skills were performed by the dance faculty (discussed later in this chapter) within the confines of the Dance Building on the University of Utah campus, and submitted to the principal investigator in March of 1985 (see Appendix B).

Measurement of Predictor Variables

Height, Weight and Age

Height was measured to the nearest 0.1 centimeter. The subjects stood erect with feet together and shoes off. Weight was measured, in kilograms, with the dancers wearing a light swimsuit. In addition, age was recorded in years and months.

Skinfolds

Measurement of the triceps skinfold was obtained as described by Behnke and Wilmore (1974). A Lange skinfold caliper was used, and the resultant measurement was recorded to the nearest millimeter (mm). The Lange caliper is designed to provide a constant pressure of 10 gm/mm.

Bone Diameters

Measures of biacromial and bitrochanteric bone diameters were obtained as detailed by Behnke and Wilmore (1974). These measurements of bone diameters are measures of shoulder and hip widths, respectively. A wooden, sliding anthropometer was utilized and both measurements were performed in duplicate; the mean value being reported to the nearest 0.1 centimeter (cm).

Body Girths

The following girth measures were obtained, as outlined by Behnke and Wilmore (1974) and recorded to the nearest 0.1 centimeter (cm):

ANKLE: minimal girth, superior to the malleoli.

CALF: maximal girth.

KNEE: midpatella level, slightly flexed, weight transferred to opposite leg.

THIGH: maximal thigh girth or just below the gluteal fold.

HIPS: anteriorly, at the level of the symphysis pubis, and posteriorly, at the maximal protrusion of the gluteal muscles.

WAIST (ABDOMEN I): Laterally, midway between the lowest lateral portion of the rib cage and the iliac crest, and anteriorly, midway between the xyphoid process of the sternum and the umbilicus. This level is the natural waist and is readily identified as the level of minimal abdominal width when the side profiles are slightly concave.

BREAST: maximal circumference of the thorax at the level of the breasts, including the material of the unpadded top of the bathing suit, at midtidal volume.

SHOULDERS: laterally, at the maximal protrusion of the deltoid muscles and anteriorly, at the articular prominence of the sternum and second rib.

BICEPS, EXTENDED: maximal girth of the midarm when the elbow is locked in maximal extension with the underlying muscles fully contracted.

FOREARM: maximal girth with the elbow extended and the hand supinated.

WRIST: minimal girth just distal to the styloid processes of the radius and ulna.

Body Composition

A hydrostatic weighing technique was used to determine body composition. The underwater weighing took place in the natatorium's diving pool at the University of Utah. The pool temperature was 29 ° C. A wooden 2 x 4 board was clamped to the lifeguard platform with the end extending past the platform. A spring-loaded catillon scale was suspended from the end of the board. A hook was attached to the bottom of the scale. Four chains were connected to the hook. Each chain was attached to one corner of a 3 foot by 5 foot rectangular frame made up of PVC tubing. This framework was suspended horizontally approximately 8 inches underwater.

Upon entry into the diving pool the subjects were asked to assume a prone position on the PVC-tube framework. A few minutes were allowed for the subjects to become familiar with this position while instructions were given. The dancers were instructed to expel as much air as possible from the lungs as they submerged their head. They were told to hold this underwater position as quietly and long as possible (10-15 seconds) until

three consistent measurements were obtained. Underweight was recorded when the scale was steady. This was usually accomplished in four to six trials. Residual lung volume was estimated by calculation from regression equations developed at the University of Nevada at Reno (unpublished). Estimations of percent body fat were calculated using the Siri Equation (1956). A computer was used for these purposes.

The Levels of Dance

There are four categories of dance levels at the University of Utah, referred to as first year (129), second year (229), third year (329), and fourth year (429 or Company Class). The 429 group performs as a ballet company, therefore the designation- 'Company Class'. Since the dancers in the Ballet Department are also students in a 4 year collegiate institution, they are subject to the standard college levels (freshman through senior) according to their academic standings, in addition to the four categories of dance mentioned above. However, progression through the academic ranks toward graduation as a senior does not necessarily carry with it progression through the four categories/levels of dance proficiency established by the ballet department. This latter progression occurs independently of academic progession and is a function of technical ballet skills, dance

achievement, and maintenance of an appropriate physical appearance, which is consistent with and influenced by the very same standards applied at the professional level.

Stage Appearance and Ballet Dance Skills

Stage Appearance

Upon notification by the principal investigator of the participation of a given dancer, the Ballet Department dance faculty evaluated that dancer. The faculty raters used a 5 point Likert scale to rate the dancers (see Appendix B). Since different faculty members are responsible for the training and supervision of each of the four different (dance) ability levels, there was one distinct faculty rater for each level, for a total of four raters. Therefore, each dancer was rated by one faculty member. The original design of the study was to include a fifth faculty member/rater who was to evaluate all 45 of the subjects. Time constraints by ballet faculty members prevented this interrater reliability check. The assessments of stage appearance were submitted to the principal investigator, together with the technical dance skills evaluations, at the end of the data collection period. See Appendix B for a copy of the form used to record the evaluations.

The ballet faculty confers on the assessment criteria for stage appearance and technical dance skill three times each year when evaluating prospective scholarship recipients. At that time, individual ratings are then compared and discussed to ensure interrater reliability. Prior to initiation of this study, an audition for department scholarships was conducted (April, 1984). All four faculty raters were in attendance for this audition. Each of the 9 applicants (all of whom were eventually admitted into the Ballet Department for the '84-'85 academic year) applying for scholarships was evaluated by each of the four faculty raters. The faculty ranking of these dancers using the stage appearance and technical dance skills criteria (see Appendix B) were identical for the first seven places (Barbara Hamblin, personal communication, Oct. 1985). In November (1984) the faculty conducted another audition for scholarships. Again, ratings were compared and discussed to further ensure interrater reliability. See Appendix C for the criteria and considerations for the stage appearance and technical dance skills evaluations. Therefore, even though a formal interrater reliability check was not implemented for this study, the faculty raters have continuously subjected these rating procedures to scrutiny.

Technical Dance Skills

The assessments of the technical dance skills were also completed for each subject/dancer after notification by the principal investigator of participation in the study. Again, a 5 point Likert scale was used to rate the dancers in each of seven technical ballet dance skill categories. The criteria for these seven categories were established by the dance department at this university and influenced by the standards of classical ballet as expressed in the United States (see Appendices B and C). The seven categories were then totaled to derive an overall evaluation of dance skill. These total scores (i.e., "Total") were used in the statistical analyses. The rater reliability considerations relative to evaluating technical dance skill are identical to those previously discussed for the evaluation of stage appearance.

Design of the Study

This study was descriptive in design, correlational in nature, designed to explore possible relationships between a battery of predictor variables and the criterion variables-- stage appearance and technical dance skills. Subject selection was essentially on a volunteer basis.

Limitations and Delimitations

Conclusions derived from this study are necessarily delimited to the population of female, ballet dancers enrolled in the Ballet Department at the University of Utah between the study period of May, 1984 to March, 1985. Predictor variables were delimited to body girths, triceps skinfold, age, height, weight, and body composition by hydrostatic weighing. Criterion variables were delimited to evaluation of stage/physical appearance and technical dance skills. It is probable that other measurable variables would provide some value in addressing the research questions which, perhaps, will be introduced into further research in this area of study.

Conclusions may be limited by the fact that data were collected over a 9 month period, thereby possibly introducing variability as a function of time. Conclusions may be further limited by the lack of a formal interreliability check of the ballet faculty raters (of stage appearance and dance skills).

Statistical Analysis

Data were tabulated and statistical analyses performed by the University of Utah Sperry 1100-72 Computer; SPSS package (version- level 9), the Operating System- Exec. 8. In addition to descriptive statistics, simple regression analyses, multiple regression and factor analysis were

performed to illuminate simple relationships as well as to explore more complex relationships applicable to the research questions.

CHAPTER III

DATA AND RESULTS

Analysis of the data included the following: a) descriptive statistics of both predictor and criterion variables, b) calculation of body composition parameters and, c) correlation of predictor statistics with the criterion statistics.

Consequently, the data and results presented in this chapter are divided into three sections. The first section includes the descriptive statistics of the predictor variables: age, height, weight, the 11 body girths measured for construction of bar graph profiles, biacromial and bitrochanteric bone diameters, triceps skinfolds, percent body fat and lean body weight. The second section presents the descriptive statistics of the criterion variables: stage appearance and total technical dance skills. The third section presents the Pearson Correlation Coefficients (Kerlinger, 1979), calculated to determine the relationships between the predictor variables and the criterion variables. Additionally, multiple stepwise regression analyses were utilized to ferret out the best combination of predictor variables for prediction of the criterion variables. Factor analysis was

utilized to determine which variables are related and how much they related, in order to reduce variable complexity (Kerlinger, 1973). At a practical level, factor analysis provided a means to simplify the variable picture in order to permit construction of a predictive scale, as well as identifying which variables measure essentially the same underlying factor(s), for simplification of future research. In response to research question number one, the following results are presented.

Descriptive Physical Characteristics of Preprofessional, Collegiate Ballerinas

The subjects (n = 45) ages ranged from 16.3 to 21.8 years with a mean age of 19.1 years. Age of subjects, by dance level, is illustrated in Figure 1. Height measurements (centimeters and inches) ranged from 152.4 cm (60.0 in.) to 177.8 cm (70 in.), with a mean of 166.3 cm (65.5 in.). Weight measurements (kilograms and pounds) ranged from 45.9 kg (101 lbs) to 68.2 kg (150 lbs) with a mean of 54.2 kg (119.3 lbs). Height and weight of subjects, again by dance level, are depicted in Figure 2.

Anthropometric Characteristics

The anthropometric measures: body girths, bone diameters, and triceps skinfolds are listed in Table 1. The mean values and standard deviations for

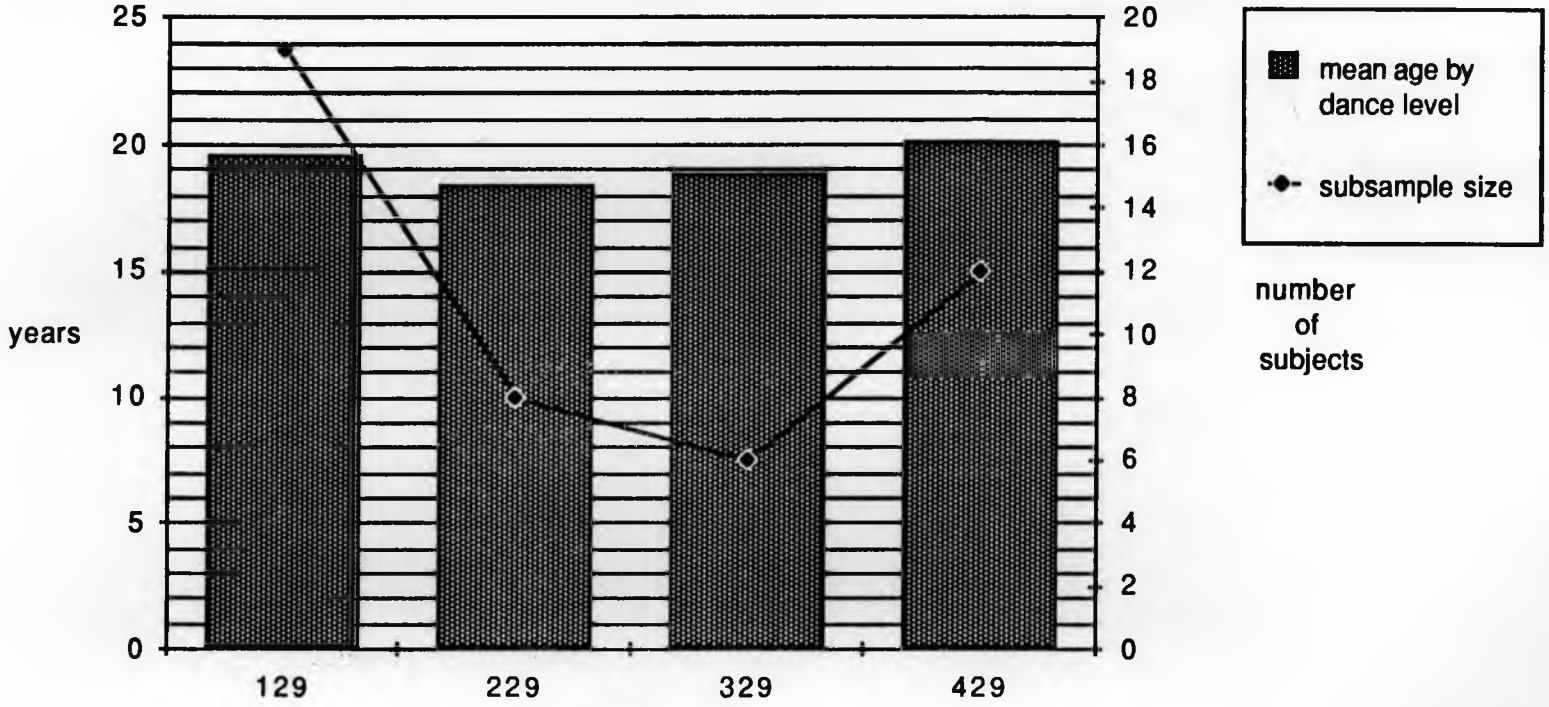

Figure 1

Age and Number of Subjects at each Dance Level

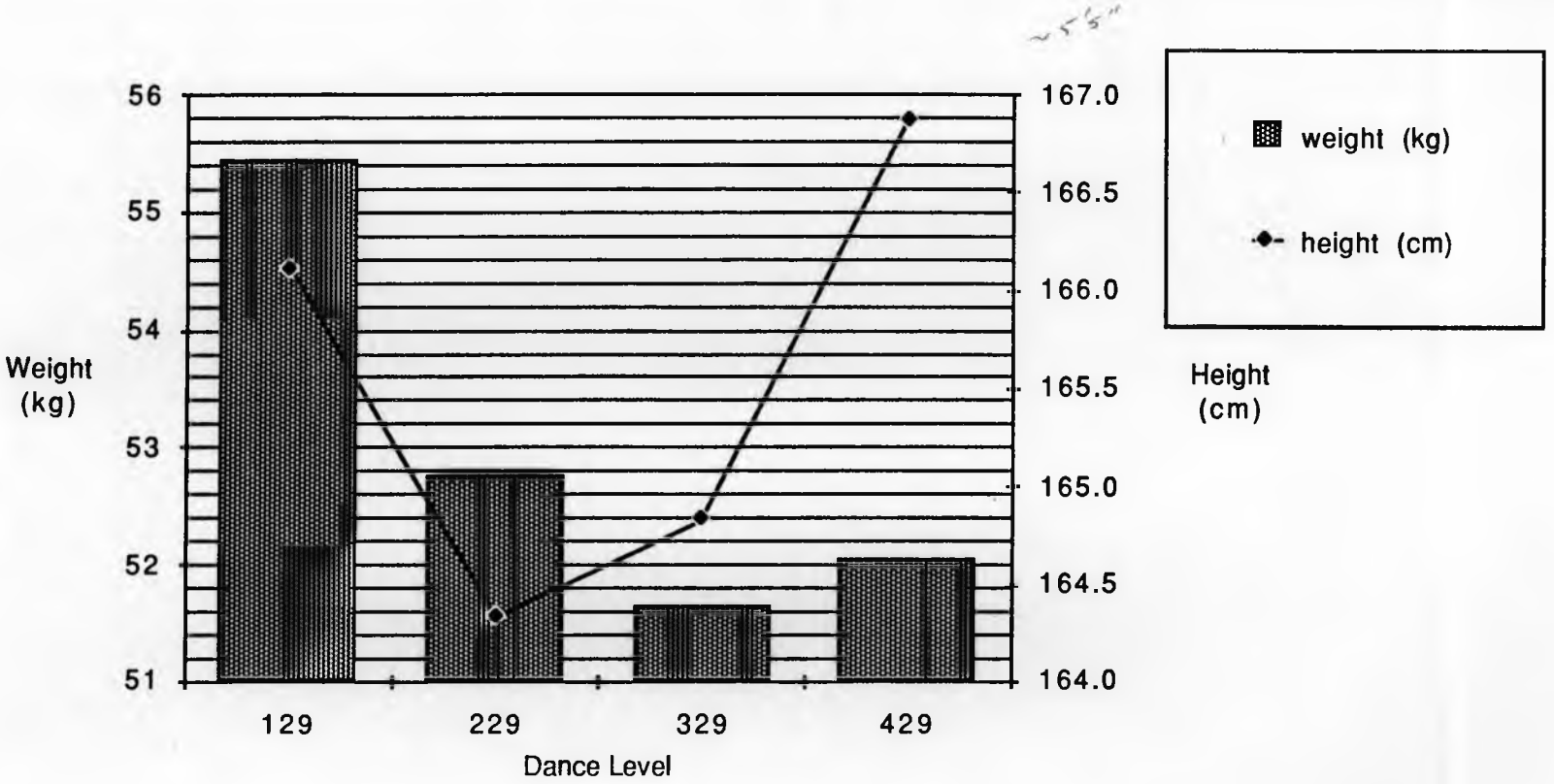

Figure 2

Comparison of Heights and Weights for the 4 Dance Levels

Table 1.

Descriptive Characteristics of Female, Collegiate Ballet Dancers

	Dance Level				
	129	229	329	429	TOTAL
WRIST (cm)	14.7 ± .94	14.5 ± 1.2	14.5 ± .74	14.5 ± .50	14.5 ± 0.87
FOREARM	22.2 ± 1.2	21.6 ± 1.49	21.7 ± .69	21.3 ± .52	21.8 ± 1.11
UP ARM	23.7 ± 1.99	22.4 ± 2.32	22.3 ± 1.59	21.5 ± .66	22.7 ± 1.19
SHOULDER	95.4 ± 4.03	93.7 ± 3.31	91.9 ± 2.41	92.0 ± 2.38	93.7 ± 3.61
CHEST	86.3 ± 6.9	83.6 ± 5.82	83.1 ± 2.02	81.6 ± 3.10	84.1 ± 5.64
WAIST	66.6 ± 3.31	64.8 ± 5.69	62.7 ± 1.96	62.8 ± 2.50	64.7 ± 3.89
HIP	86.6 ± 5.74	84.3 ± 4.94	86.0 ± 2.80	84.2 ± 3.12	85.5 ± 4.10
THIGH	53.7 ± 3.36	52.2 ± 3.51	52.4 ± 2.01	52.0 ± 2.47	52.8 ± 3.10
KNEE	36.4 ± 2.54	34.7 ± 2.10	34.6 ± 1.04	34.5 ± 1.59	35.4 ± 2.21
CALF	34.8 ± 1.54	34.2 ± 1.84	34.4 ± 1.46	33.9 ± 1.10	34.4 ± 1.49
ANKLE (cm)	20.8 ± .89	20.2 ± 1.06	20.2 ± .80	20.3 ± .61	20.5 ± 0.86
SUM (cm)	541 ± 2.95	526 ± 3.03	524 ± 1.59	518 ± 1.69	529 ± 2.45
BIACRO. (cm)	32.5 ± 1.47	32.9 ± 1.81	31.5 ± 1.68	31.4 ± 1.39	32.1 ± 1.60
BITROCH. (cm)	31.0 ± 1.07	30.9 ± 1.26	30.7 ± .89	31.0 ± 1.54	30.9 ± 1.19
TRICEPS SK. (mm)	12.9 ± 3.99	17.5 ± 3.18	11.8 ± 2.23	12.9 ± 3.50	13.6 ± 1.89
% FAT	20.5 ± 5.23	17.9 ± 7.00	16.1 ± 5.62	16.1 ± 3.91	18.1 ± 5.32

each dance level as well as a total mean value for the group are presented.

Bone Diameters and Frame Size

The two bone diameters, biacromial and bitrochanteric, were measured to gather descriptive data on the frame size of this population, using the criteria established by Katch and Freedson (1982). Accordingly, it was observed that 1 dancer had a small frame, 41 had medium frames, and 3 had large frames. These results reinforce Katch and Freedson's observations that small and large frame sizes occur infrequently.

Bar Graph Profiles

The circumferences (body girths) were used to construct bar graph profiles, depicting the gross morphological characteristics of each of the four dance levels. The profiles are contrasted with each other, and a normal population of college-age, nondancer females (from Behnke & Wilmore, p. 57), in Figure 3.

Body Composition

Percent body fat, estimated from the hydrostatic weighing, ranged from 9.2 % to 32.7 % with a mean of 18.1 %. The mean percent body fat of each dance level group was as follows: 20.5, 17.9, 16.1, and 16.1 for the 129, 229, 329 and 429 levels, respectively (see Table 1). Lean body weight

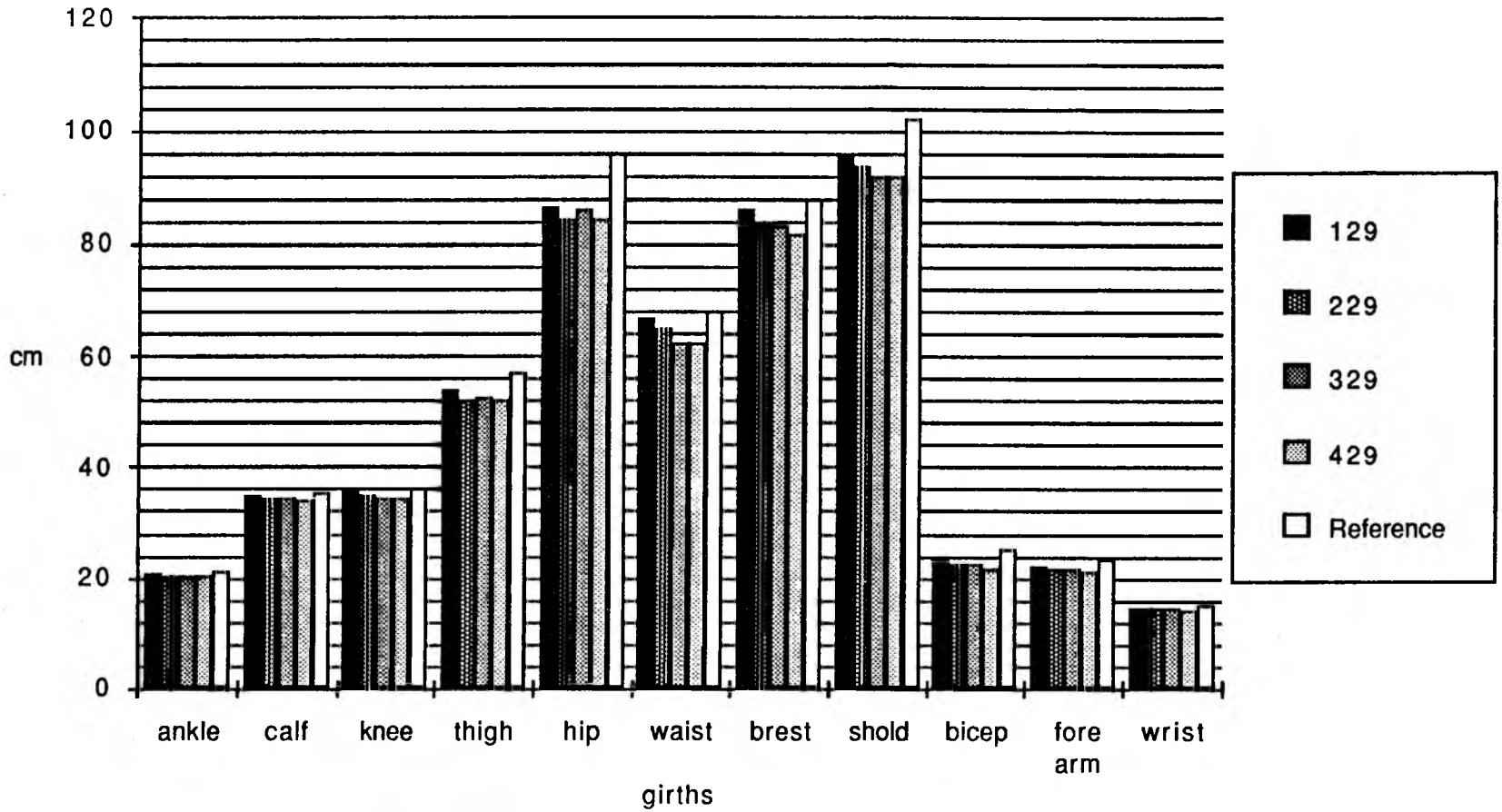

Figure 3

Comparison of Body Girths for Dancers and Reference Women

was calculated by subtracting percent body fat from 100% and multipling by weight. These values ranged from a low of 35.5 kg (78.1 lbs) to a high of 53.7 kg (118.1 lbs) with a mean of 44.4 kg (97.68 lbs) and a standard deviation of 3.95 kg (8.70 lbs).

Stage Appearance and Technical Dance Skills

Stage Appearance

The assessments of the physical appearance of the dancers, by the ballet faculty at the University of Utah, are reported as mean values for each dance level (129-429) and for the entire group in Figure 4 and Table 2. The evaluation of stage appearance was based on factors described in Appendix C, but reported to the principal investigator as only one number on the 5 point likert scale.

Technical Dance Skills

The total of dance skills, on the other hand, was the sum of seven components, each of which was evaluated separately and reported as such. The total of these seven components was summed, not by the dance faculty, but by the principal investigator after the data collection period was over. The seven components are as follows: alignment and placement, turnout, muscle strength, adagio quality, overall coordination, allegro quality and

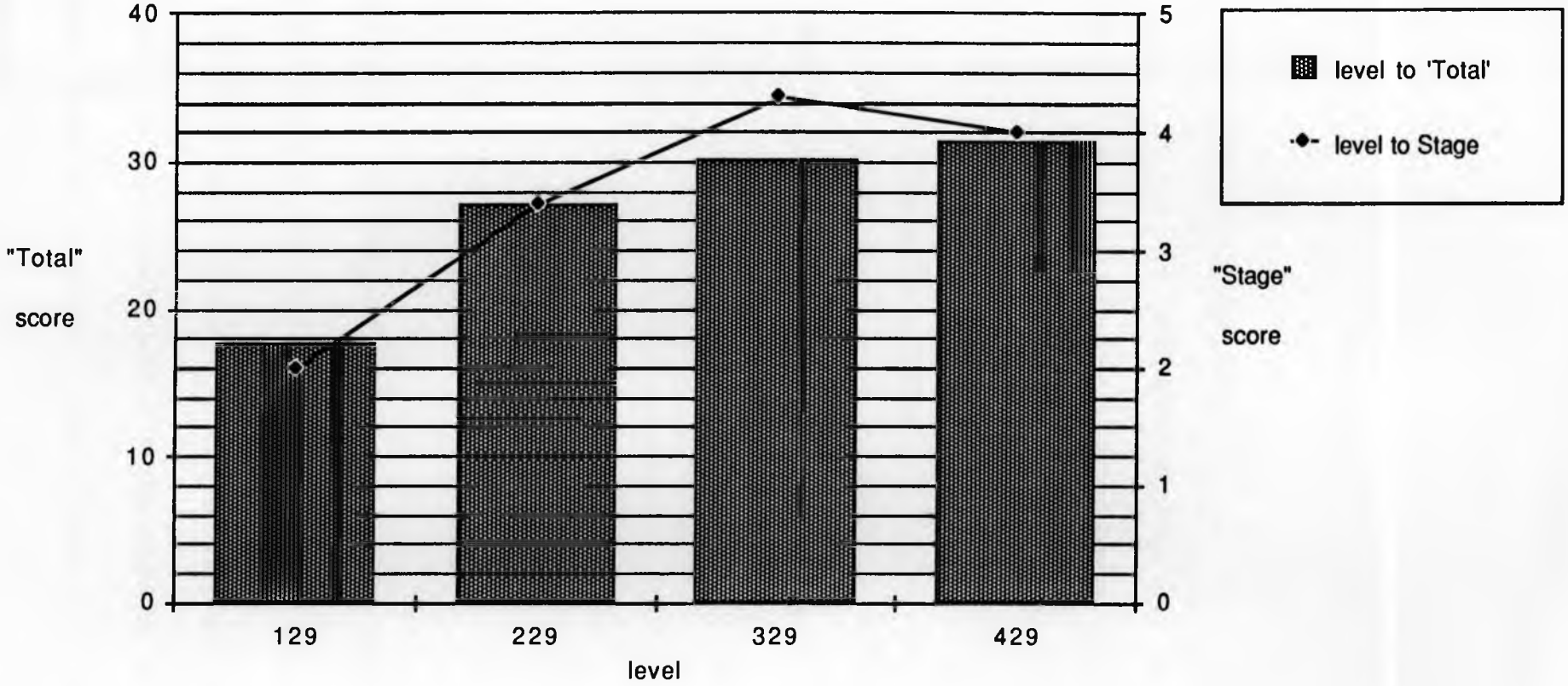

Figure 4

Total Dance Skills and Stage Appearance of the 4 Dance Levels

Table 2.

Mean STAGE and TOTAL Scores for the 4 Dance Levels with Standard Deviation

	Dance Level				
	129	229	329	429	MEAN
'STAGE'	2.0 ± 1.1	3.4 ± 1.1	4.3 ± 0.5	3.9 ± 0.3	3.1 ± 1.27
'TOTAL'	17.7 ± 7.5	27.1 ± 4.8	30.2 ± 2.9	31.4 ± 2.0	24.8 ± 7.84

point work. For simplicity, and since only the sum (i.e., "Total") of the dance skills was used in the analyses, only the 'Total' score is reported here.

Both the stage appearance scores and the total dance skill scores are unitless, as they represent ordinal measurement on the 5 point Likert scale used by the ballet department. A perfect score is 35, that is, 5 times the 7 components of ballet skills.

Correlation of Descriptive Statistics with Criterion Variables

Due to small subsample sizes in the second and third level groups (229 and 329 classes, respectively), comparison of group means was not done; however, correlation analyses were carried out on the group as a whole. Many relationships were explored in an effort to ferret out those physical characteristics which might prove of value relative to the goal of predicting success in achievement of stage appearance or technical dance skills.

Pearson Product Moment Correlation Coefficients

Each of the predictor variables was correlated, independently, with each of the two criterion variables. These Pearson Correlation Coefficients are listed, together with levels of significance, in Table 3. The Pearson Correlation Coefficients revealed several statistically significant relationships. Those 'R' values greater than .6 are highlighted in bold print.

Multiple Regression Analysis

As this study was nonexperimental in nature, and involved multiple variables, multiple regression analysis was utilized to explore complex relationships not discernable with simple descriptive statistics or Pearson

Table 3.

Pearson Correlation Coefficients (R) of the Predictor Variables and the Two Criterion Variables, with Corresponding Levels of Significance, p.

	STAGE R/p	TOTAL R/p		STAGE R/p	TOTAL R/p
AGE	.0490	-.0031	SHOULDER	-.5018	-.3613
	.375	.492		.000	.007
HEIGHT	-.0630	-.0717	CHEST	-.4304	-.3524
	.341	.320		.002	.009
WEIGHT	-.6592	-.5702	WAIST	-.6851	-.5351
	.000	.000		.000	.000
% FAT	-.5031	-.4348	HIP	-.5374	-.4239
	.000	.001		.000	.002
TRICEPS	-.3288	-.1388	THIGH	-.5803	-.3908
	.014	.182		.000	.004
WRIST	-.4983	-.4471	KNEE	-.5489	-.5224
	.000	.001		.000	.000
FOREARM	-.6159	-.5616	CALF	-.3764	-.2924
	.000	.000		.005	.026
BICEPS	-.7180	-.5593	ANKLE	-.4026	-.3655
	.000	.000		.003	.007
BIACRO.	-.1623	.0512	COCCYX	.0867	-.0367
	.143	.369		.286	.405
BITROCH.	.0154	.0355			
	.460	.408			

Product Moment Correlation analyses. Several combinations of data were entered into the analyses in an effort to determine the best possible mix of variables for the prediction of stage appearance and total dance skills (Table 4). The variables for entry into the analyses were selected based upon a combination of their Pearson r values and their practical application in a setting such as the ballet department at this university.

Factor Analysis

Factor analysis provides a statistically powerful way to discover which of the predictor variables are correlated with each other, how much they are related, and to permit a reduction of variable complexity to greater simplicity. The factor analysis utilized yielded a Rotated Varimax Factor Matrix, with accompanying factor loadings listed in Table 5.

Table 4.

Multiple Regression Analysis--

Prediction of Stage Appearance and Total Dance Skills

A. DEPENDENT VARIABLE... **STAGE APPEARANCE** ('STAGE')

VARIABLE ENTERED ON STEP NUMBER 1... **BICEPS**
MULTIPLE R... .7195
R SQUARE... .51545

VARIABLE ENTERED ON STEP NUMBER 2... **HIP**
MULTIPLE R... .75548
R SQUARE... .57075

statistically significant (signif F = 0.000)

B. DEPENDENT VARIABLE... TOTAL OF TECHNICAL DANCE SKILLS ('TOTAL')

VARIABLE ENTERED ON STEP NUMBER 1... **WEIGHT**
MULTIPLE R... .57018
R SQUARE... .32511

VARIABLE ENTERED ON STEP NUMBER 2... **% FAT**
MULTIPLE R... .62034
R SQUARE... .38482

statistically significant (signif F = 0.000)

TABLE 5.

ROTATED VARIMAX FACTOR MATRIX of the Predictor Variable Set.

	FACTOR 1		FACTOR 2	FACTOR 3
TRICEPS	.49286		-.08412	-.33953
WRIST	**.82531**		.05542	.12977
FOREARM	**.81944**		.31585	.00561
BICEPS	**.84718**		.39115	-.25772
SHOULDER	.28352		**.82604**	.25718
BREAST	.20943		**.83537**	-.17456
WAIST	**.61976**	-------	.63882	-.00512
COCCYX	-.04393		-.04843	.33539
HIP	.34986	----	.47730	.17211
THIGH	.58668	-------	.45150	-.14808
KNEE	**.70651**		.12666	.02087
CALF	**.68217**		.13103	-.02217
ANKLE	**.66593**		.13430	.21286
BIACRO.	-.05037		.44361	.04723
BITROCH.	-.17221		.26598	**.61574**

CHAPTER IV

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

The general purpose of the study was to gather descriptive information on the physical characteristics of female ballet dancers, to contribute to the general body of scientific data on ballerinas and athletes. The study also addressed several research questions of a more specific nature. In review, they are as follows. Do any of the anthropometric variables, or combinations thereof, permit prediction of the success of these dancers in terms of achievement of technical dance skills or stage appearance? Are there distinct differences in such patterns between the four levels of dance proficiency as defined at the University of Utah? The overall goal of the study was to provide descriptive data on the physical characteristics of ballerinas to contribute to the base of knowledge on this population and on athletes in general. It is hoped that as the data base grows, sport scientists and health professionals will be better equipped to address the problems faced by this population.

Conclusions

Descriptive Physical Characteristics

Age, height and weight. The age range of this population, from 16.3 years to 21.8 years, is slightly lower than that of most other college populations, as is the mean of 19.1 years (Behnke & Wilmore, 1974). This is not surprising, given the fact that ballet is an endeavor of youth, involving extremes of flexibility, muscular strength, grace and the sylph-like appearance which become difficult with increasing age. Furthermore, this ballet institution maintains an open door policy of acceptance of any individual 14 years of age or older who can pass the first year level (129) of dance skills; physical appearance has minimal influence on acceptance. Two of the subjects in this study participated under such conditions.

Height ranged from 152.4 to 177.8 cm, with a mean of 166.3 cm. The mean is slightly higher than that of two populations of ballerinas reported in the literature-- 164.1, 165.0 cm (Dolgener et al., 1980; Mostardi, R. A. et al.,1983) and a normal, nondancer population (Behnke & Wilmore, 1979)-- 164.9 cm.

Weight ranged from 45.9 to 68.2 kg, with a mean of 54.2 kg. The breadth of the range is accounted for by an extension of the open door policy mentioned above. That is, entry into the ballet program has no weight

limits, only that the applicant can pass the first year level of dance proficiency. Only as the dancer improves and begins working her way up through the ranks (i.e., from 129 toward 429) does physical appearance begin to dictate progression. Several dancers in the first year class were quite heavy, with no chance of progressing beyond the 229 class unless they were to lose considerable weight. Even when including these relatively heavy dancers, the mean of the group of dancers in this study was smaller than that reported for the nondancers referred to above.

Body girths and bar graph profiles. As illustrated in Figure 3, the bar graph profiles for the 4 levels of dancers as well as the normal population of nondancers demonstrate variability between the groups in this study and the nondancer population. There were no statistical analyses performed on these differences, due to the small subsample sizes, but future studies at this institution will address this issue. There were, however, differences between groups which appear to be of practical significance for the dancer and dance professional concerned with appearance standards, in particular, and may be an appropriate application of profiling data. Refer to Table 1 for the means and standard deviations of each anthropometric variable for each of the four groups of dancers and the overall mean of the study population.

The sums of all body girths for each level of dance (Figure 5), are of particular significance and, perhaps, best summarize the anthropometric data. The means and standard deviations are as follows, from 129 through 429, respectively: 541 ± 2.95, 526 ± 3.03, 524 ± 1.59, 518 ± 1.69 centimeters, converted to meters for illustration in Figure 5. There are two messages in these data. The first, and perhaps most obvious, is that there are considerable differences between the sums of body girths for the four groups. The differences are progressive through all four groups, and there is a substantial difference between the first and fourth year groups. These values are representive of a physical profile, much like a three dimensional sillouette. Such an analogy may, in fact, suit the assessment of dancers as three dimensional entities who glide, leap and twirl through vignettes of human emotion as performing artists.

The average standard deviations of the set of body girths within each group, the standard error of estimates, are also compared in Figure 5. These average standard deviations represent the anthropometric variability within each group and may, in fact, be a graphic illustration of selection processes which take place between the 4 levels of dance proficiency at this institution. The dramatic differences between the first and second year dancers and the third and fourth year dancers, in terms of anthropometric

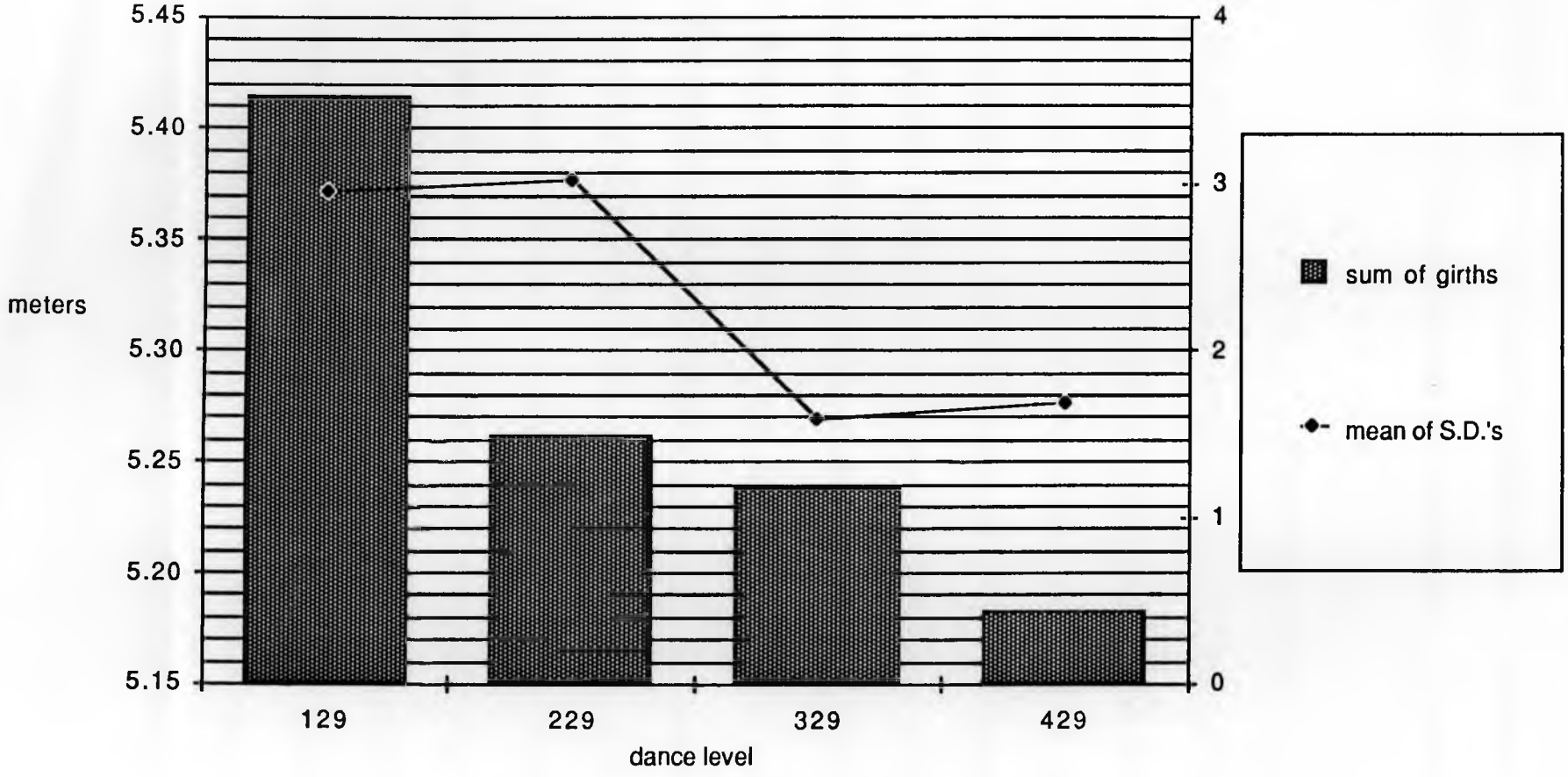

Figure 5

Sum of Girths and Variation of Girths

variability, suggest that there is a divergence toward a relatively narrow set of physical standards defined, at least in part, by body girths. This should surprise no one who has frequented the ballet; it is often said that "they all look the same," in reference to female ballet dancers.

Summarizing the data illustrated by Figure 5, it appears that between the first and second year classes there is a dramatic decrease in overall size (i.e., girth) of the dancers, with no change in the variability of these physical characteristics. As the selection processes continue between the second and third year levels, the dancers continue to decrease in girth measurements, but the big difference is the dramatic drop in variability of body girths between these groups-- the remaining successful dancers closely resemble the physical homogeneity of the classical ballerina. Between the third and fourth year levels there is, again, a relatively large drop in overall girth size with no change in variability. The end product of this dance institution, the Company Class ballerina, is both relatively small and invariate, in terms of body girths.

Bone diameters. Measurement of bone diameters was performed to determine frame size, and contributed further to the gross anthropometric description of the dancers. The calculated frame sizes, based on the

criteria of Katch and Freedson (1982), yielded no significant patterns of distribution that were not obvious from casual observation. The bone diameter data also proved of no practical significance in differentiating the four levels of dancers, nor did it increase the predictability of the criterion variables by the anthropometric variables.

Triceps skinfolds and waist to coccyx length. The triceps skinfolds were obtained to provide additional anthropometric data on this population, and for the use of the ballet department in the evaluation of nutritional status of the dancers. This latter purpose will be pursued by the ballet department and not reported further in this study. The skinfold data, as reported in Table 1, reveal no significant patterns of distribution or value to prediction of either dance skills or stage appearance.

Waist to coccyx length was measured at the request of the ballet faculty, and reported (Table 1) to contribute to the gross anthropometric assessment of these dancers. The waist to coccyx length of the 4th year (429) group is 1.1 cm longer than the mean length and 1.3 cm longer than the next greatest value, found in the 1st year group. This is one of the few, single anthropometric variables which appears to be significantly different between the 3rd and 4th year groups, varying, on the average, by 2.1 cm.

Perhaps this is one of those genetically controlled variables which partially influences, at the higher levels of ballet aesthetics, who gets selected for corps positions in companies.

Body composition. Hydrostatic weighing to determine body density permitted the estimation of body fat and lean body weight for this group. The range from 9.2 to 32.7 percent body fat is exceptionally broad for a population of ballet dancers. As explained previously, the open door policy of this university provides a probable explanation for this range. There were dancers in the 1st and 2nd year groups who were too heavy for consideration for the upper level, and certainly professional ranks, but were allowed to participate in the ballet program. Some of these dancers may, through concerted effort (e.g., dieting, exercise), achieve a level of weight and size allowing their progression through the dance levels, but experience at this institution would suggest this is unlikely (Barbara Hamblin, personal communication, Oct. 1985). The mean value of 18.1 % body fat, in spite of inclusion of these relatively overweight 1st and 2nd year dancers, falls within the expected range reported in the literature (16.9% by Calabrese et al., 1983; and 16.4 % by Clarkson et al., 1985). The Company Class (429), followed closely by the 3rd year (329) class, both

with a mean of 16.1 % fat, better typify the caliber of ballerina at the professional level. Such a statement is supported by the fact that all of the 1985-86 Company Class (429) dancers were accepted into professional companies upon completion of the academic year. The fact that both the 329 and 429 groups average the same percent fat value would suggest that this is the approximate value that the first two class levels should aspire to in order to increase their chances of success in this ballet department. Since body fat is associated with a number of physiological functions (e.g., muscular strength, endurance, and susceptibility to injury) which influence performance, as well as stage appearance, awareness of and attendance to this characteristic would benefit the dancer and teacher/choreographer alike.

Determination of percent body fat was a major reason for initiation of this study effort; to permit and promote a scientifically sound approach to weight loss, rather than continuing the archaic practice of setting goal weights without regard for body composition variables. The Ballet Department at the University of Utah, after receiving data from this study, has incorporated body composition assessment and variables into the weight-related goals for its dancers and increased its goal weights.

Lean body weight (LBW) was reported and utilized in the statistical

analyses, including the construction of a LBW to % fat ratio. The study population statistics of the LBW/% fat ratio are as follows: $\bar{x}$ = 5.9, s.d. = 2.14, minimum = 2.7, maximum = 12.1, range = 9.4. Whether singly or in concert with percent fat, this parameter provided no additional predictive ability of the criterion variables. The Pearson r values, illustrating the relationship between the LBW/% fat ratio and "Stage" and "Total" are .330 and .312, respectively.

Stage Appearance and Technical Dance Skills

Stage appearance. Stage appearance, assessed subjectively by the ballet faculty, represents criteria which are solidly based in classical ballet tradition and practiced almost mechanically at this institution. The mean and standard deviation values assigned to the dancers in the four levels, 129 through 429, are illustrated in Table 3 in the results section and listed as follows: 2.0 $\pm$ 1.1, 3.4 $\pm$ 1.1, 4.3 $\pm$ 0.5, 3.9 $\pm$ 0.3, for the 129-429 classes, respectively. There is clearly a significant difference between the stage appearance of three out of the four groups, as perceived by the faculty. The small subsample size of the 3rd year (329) group (n = 6) permits sampling error to influence these values. The two dancers in the 329 class who received perfect scores on the 5 point Likert scale used to

assess the dancers' stage appearance were selected to dance with the Company class the following year (1985-86), and accounted for the high stage appearance score of the 329 class. It is important to stress the fact that there is no clear delineation between the two top level groups in terms of either stage appearance or total technical skills. There are, apparently, certain "undefinables" which influence the selection of dancers for the Company class; among these are injuries. Though not evaluated in this study, the frequency, severity, duration, and timeliness of injuries, which most dancers deal with on such a regular basis, does influence the selection process for "Company" status. In this respect, the selection process for the performing company at this university is similar to that of professional ballet companies. Additionally, the waist length (i.e., distance from tip of coccyx to waist), as mentioned previously, may influence the appearance of the dancers as perceived by the faculty raters. The practical difference between the 329 and 429 classes in terms of girth sums, while appearing to be significant, is as yet, ill-defined.

Total of technical dance skills As illustrated in Table 2, there is not only a progressive increase in "Total" scores all the way through the four dance levels, but also a progessive and marked decline in the variability of

the scores as illustrated by the standard deviations for the group data. These relationships are consistent with expected results, since dancer skill is such a major part of the classification process of dancers into the four levels established at this university. The difference between the 329 and 429 classes may have been even greater were it not for the fact that two dancers in the 329 class had a "Total" score which was several points higher than the mean for the 429 class. One of these 329 dancers had previously been a member of the Company class but had elected to drop down to the 329 class due to her unwillingness to maintain the weight standards of the Company Class. The other performed with the Company class the following year as one of its premier dancers.

Correlation of descriptive statistics with stage appearance and dance skills. The primary statistical effort in this study was to illuminate practical, significant relationships between any of the physical measures obtained and the criterion variables- stage appearance and technical dance skills. The crux of this effort was to define physical characteristics of this population of female ballet dancers which would permit prediction of stage appearance and dance skills.

The Pearson Correlation Analyses (Table 3) revealed the following four

anthropometic variables as being most significant in the prediction of stage appearance: biceps girth, waist, weight, and forearm. The corresponding Pearson r values were as follows, respectively: -.7180, -.6851,-.6592 and -.6159. The same 4 variables also provided the best predictive value for total dance skills, with Pearson r' s as follows: -.5593, -.5351,-.5702 and -.5616, respectively. The parallel appearance of these 4 anthropometric variables as the best predictors of both criterion variables would suggest that stage appearance and the total of technical dance skills are related to each other. The Pearson r between 'Stage' and 'Total' is, in fact, quite high (i.e., .833); suggesting that "Stage" and '"Total" are not independent of each other.

The big surprise in these analyses was the strong relationship between biceps girth and stage appearance (r = -.718). Use of this variable together with hip girth in a multiple stepwise regression analysis, to predict stage appearance, yielded a multiple r of 0.7555, a slight increase over the Pearson r of biceps as a single predictor. The variance, r^2, of stage appearance accounted for by the combination of biceps and hip girth, was then 57.075 percent. Forearm girth also was strongly correlated with stage appearance (r = .6159), which is discussed further in the factor analysis section.

Factor analysis. In order to reduce the number of variables, to simplify the picture, factor analysis was applied to the predictor variable set (Table 5). Such analysis permits the determination of which of the variables are related (i.e., measure essentially the same thing) and to what extent they are related. Several statistical relationships were identified which support logical hypotheses.

By selecting 0.600 as the level of significance for the factor loading coefficients, there are several variables which appear to be strongly related, and suggest that Factor 1 could represent an "extremities factor," factor 2 a "trunk factor," and factor 3 a "frame factor." On factor 1, wrist, forearm and biceps have factor loadings of 0.82531, 0.81944, and 0.84718, respectively, and are poorly loaded on factors 2 and 3. Ankle, calf and knee have factor loadings of 0.70651, 0.68217, and 0.66593, respectively on factor 1, and are also poorly loaded on factors 2 and 3. Though just below the cutoff value of 0.6, the factor loading of thigh on factor 1 is 0.58668, on factor 2 is 0.45150, and negligible on factor 3. That is, thigh is split between factors 1 and 2. The remaining variable heavily loaded on factor 1 is waist, with a factor loading of 0.61976; but this variable is also heavily loaded on factor 2, that is, split between factors 1 and 2 (0.63882), negligible on factor 3.

The variables which are clearly associated with the extremities: wrist, forearm, biceps, ankle, calf, and knee, are all heavily loaded on factor 1 (>0.66) and poorly loaded on factors 2 and 3. The thigh, with its split loading between factors 1 and 2 might be considered a visual transition from leg to trunk. The waist variable is relatively well-loaded on both factors 1 and 2 (i.e., split), slightly higher on factor 2, but less than any of the six variables listed above on factor 1.

Factor 2, labeled the "trunk factor," revealed a pattern suggesting that the shoulder, breast and waist variables measure essentially the same thing; with hip, thigh and biacromial showing a moderate but significantly lower correlation with this factor.

Discussion

Although the pursuit of the sylph-like body of the classic ballerina appears to have a dramatic impact on both young aspiring dancers as well as professional dancers, little scientific documentation of the ideal ballet physique exists. In fact, until very recently, ballet was one of the last major bastions of scientific void.

This situation is changing and the current interest in ballet as an athletic event and the ballet dancer as athlete has revealed many physical

and psychological problems within the world of ballet. While many of the problems are found among other athletes, some, at least in their magnitude, are unique to ballet, especially female dancers. These problems are: malnutrition (Calabrese, 1982), healing (Gordon, 1983; Peterson, 1982), menstrual abnormalities (Cohen et al., 1982; Drinkwater et al., 1981; Frisch et al., 1980), and eating disorders (Benson et al., 1985; Garner & Garfinkel, 1978). All of these problems are related, in varying degrees, to the relentless pursuit of the ultrathin look, the "Balanchinian aesthetic" (Calabrese, 1982). It is the belief of the investigator involved in this study that the world of ballet can retain its aesthetic standards without sacrificing so many of its aspirants to diet-related disorders. These disorders often result from the application of aesthetic standards to thousands of ballet aspirants without providing them with scientific guidance for the achievement of ideal body composition and physique dimensions. There is also a need to counsel those aspirants who do not have the biological potential to achieve the sylph-like physique required of the successful ballerina. Perhaps it is possible, as is being tried with ballet in the Soviet Union, to predict those who have the body type to survive the merciless dictates of ballet, ballet choreographers and artistic directors of professional companies.

As the science of anthropometrics develops, the application of scientific tools can be applied to the development of ballet profiles. That is, profiles of anthropometric, biomechanical, physiological and nutritional characteristics which provide predictive capability of successful ballet dancers. The successful application of such an endeavor would permit appropriate and needed counseling of aspiring ballet dancers while still young and relatively free of the dance-related problems mentioned above. Those who are ascertained to be good candidates for successful pursuit of high level ballet would be encouraged. Those who are borderline in relevant characteristics could be counseled in their deficiencies and informed of a reasonable course of action to overcome these weaknesses, and the options.

Anthropometry- prediction in ballet. Some of the physical characteristics examined in this study cannot be manipulated by training or dietary regimens, that is, they are genetically fixed. Those fixed/genetic characteristics which, upon statistical analyses, identify those dancers with little chance of meeting the fundamental criteria associated with acceptance by the ballet establishment (i.e., dance skills and appearance), could be utilized to develop the low end of a predictive scale. Those genetic characteristics associated with success, as measured by technical dance

skills and stage appearance, could be utilized to develop the high end of a predictive scale. In between the theoretical low and high ends would be a grey zone, a "zone of uncertainty" where other attributes of the dancer would determine success or failure.

In addition to fixed characteristics, there are an abundance of physical characteristics associated with dance skills and appearance which can be changed (e.g., muscle girths, strength, flexibility, body composition), thereby increasing the likelihood of success as a classical ballet dancer. As above, a predictive scale of success/failure could be developed with high and low ends to identify those with physical characteristics associated with success/failure to meet the established ballet criteria.

Rather than construct two separate scales based on whether the characteristics are relatively fixed or pliable, practicality would probably be better served by combining all the physical variables into a single "composite score" representing all the variables.

If such characteristics are demonstrated to be strongly correlated to measures of success in ballet, then perhaps it is appropriate to develop such a composite score of physical measures which are predictive of an individual's chances of success in ballet. Figure 6 illustrates a theoretical effort to develop a working model for a predictive scale. Area A is a zone

defined by composite scores which are below the threshold values which have been shown to successfully predict (given some acceptable degree of error) the likelihood of achieving acceptable physical appearance and technical virtuosity. This population is unlikely to achieve the standards necessary to perform at the level of performance of Company Class at this university or a major company. These individuals might best be served by encouraging them to pursue other endeavors or continue ballet training only as a form of exercise, self-discipline, relaxation, etc., rather than strive, fruitlessly, for a professional carrer.

Areas B and C represent dancers who have the dance skills but not an acceptable stage appearance, and vice versa, respectively, to be ready candidates for acceptance into the Company Class. These two areas represent individuals who, while perhaps not completely eliminated from the potential ranks of elite ballerinas, would have to work exceptionally hard to overcome their deficiencies in dance skills or physical appearance, or offered options.

Area D represents those aspiring ballet dancers who have the potential to achieve <u>both</u> an acceptable stage appearance and the technical dance skills to qualify for acceptance into the ranks the Company Class. It would, perhaps, be appropriate to encourage such dancers to pursue ballet to the

full extent of their desires. As many of the Company Class dancers have performed with or go on to perform with professional companies, it is reasonable to suggest that the evaluations applied to this population of ballerinas could also be of value in predicting the likelihood of being accepted into professional companies.

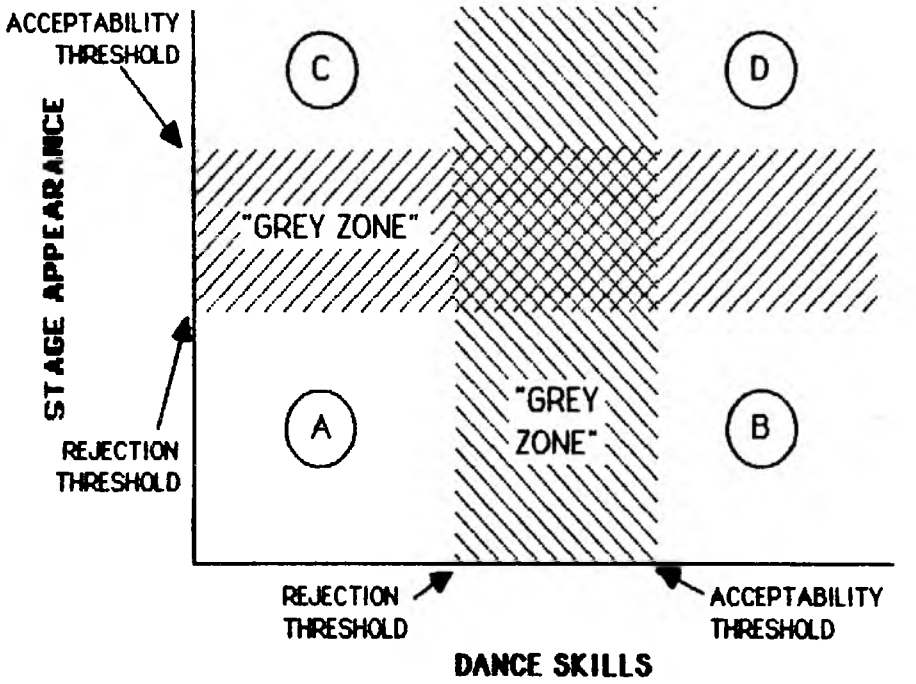

Figure 6

Theoretical, Predictive Model for Success in Ballet

With time, predictive measures and models could be developed for other ballet populations. Eventually, a set of standards, to accommodate the major styles and preferences in this country, could be developed to permit prediction of success in stage appearance and dance skills. Such an effort could be expedited by the judicious use of videotaping to establish standards for the evaluation of dancers around the country. While video examination of dancers may lack in its capacity to convey some qualities relevant to successful ballet performance, it may prove to be a useful tool in these initial efforts to establish national (international?) standards.

Concommitant with the prediction efforts, education, based upon sound health and medical practices relevant to ballet, should be made available to all interested parties (i.e., dancers and teachers alike). The goal would be not only to decrease needless suffering, but also to extend the success of those who pursue "the dance", and contribute to a healthier lifestyle.

Summary

While some individuals might object to the reduction and quantification of characteristics leading to the prediction of success in ballet, such an approach has immense potential in reducing the unnecessary pain, suffering and grief of young girls and women who strive, uncompromisingly, toward an

empty dream of sugar plum fairies in a life as a professional ballerina. The overwhelming majority, who express biological limitations which effectively eliminate them from any but the slimmest hope of achieving the standards of ballet, could be counseled as such, to reduce the needless suffering related to battling innate biological characteristics. Options for this majority, who have no realistic chance of achieving the standards of ballet, could be outlined by an informed ballet professional.

The practice of ballet provides many benefits for those who participate, as long as the participants appreciate the realistic limits of their bodies and behave accordingly. The majority of children who participate in other, perhaps more traditional athletic endeavors (e.g., baseball, basketball, volleyball, track and field, etc.), do not so often commit themselves to the sport to the exclusion of other endeavors as ballet dancers so often do. Perhaps many of the young, aspiring ballerinas should be encouraged to pursue ballet in a more rational manner.

Any individual, child or adult, who participates in ballet training stands to improve flexibility, leg strength, balance, timing and discipline. There are, in fact, a growing cadre of professional athletes, such as football and baseball players, who study ballet to improve themselves as athletes (Switzer, 1983). Certainly ballet offers more to its participants than the

possibility of a professional career as a stage performer.

If, as is being done in so many other athletic endeavors as profiling becomes more refined, young ballet dancers can be identified at an early age as to the specific characteristics which must be changed, or which cannot be altered and therefore prevent achievement of the standards of the discipline, much of the suffering expressed today can be reduced. The fanatical dieting and many hours and years of single-minded training might be tempered with a more reasonable approach based upon realistic goals.

It is hoped that the efforts and suggestions made in this exploratory study will help to define the direction and appropriate course of action for future research efforts into the world of ballet.

Recommendations

To insure both accuracy and consistency, future efforts to develop well-defined, anthropometrically based, predictive evaluations need to utilize standardized instruments and methodology for the assessments. The anthropometric measures are simple and quick to perform, and most of the instruments for measure inexpensive, but are subject to artifact unless the technician is familiar with gross body morphology and anatomic landmarks associated with the specific measures selected. In order to establish

profiles and predictive models for the evaluation of potential success in ballet, standardization of such methodology and technique, as well as its application, is imperative.

Evaluation of body composition should be assessed with the most accurate and reliable methodology available. At present this still seems to be hydrostatic weighing with direct measurement of residual lung volume. Estimation of percent body fat by skinfold testing typically results in values within $\pm$ 3.7% fat in two out of three subjects, relative to hydrostatic methodology (Lohman, 1982); a level of variability not acceptable in research efforts.

The preparation of the subjects for the measurements, including hydrostatic weighing, can influence the values obtained. For example, the manner in which the subjects are attired, e.g., one or two piece bathing suits, versus tights, will alter the body girths obtained. Since possession of such attire seems to be a regional phenomenon, it should be determined which style (e.g., bathing suit) is most popular to ensure consistency in anthropometric measures.

As a general course of preparation for anticipation of the inevitable problems, it is suggested that the investigator(s) become as familiar as possible with the habits and logistical circumstances of the subjects. The

extreme demands of ballet training are such that obtaining permission and cooperation of dancers is facilitated by catering to their demanding schedules and needs.

If, as was the case in this study, there is a significant lapse of time between the initiation and completion of the assessments, repeat measurements should be obtained, at least on a few of the subjects, to determine if any of the variables measured changed during the study period. At the professional and more advanced (e.g., 429) levels there is, according to the sparse literature on the subject (Dolgener et al., 1980), very little fluctuation in anthropometric morphology, but the less developed dancers may be more subject to seasonal fluctuation in physical characteristics.

The evaluations of stage appearance and technical dance skills, the criterion variables in this study, are subjective by nature. For this reason the results of such assessments are difficult, at best, to apply to any but the population(s) studied. In order to ensure the reliability of such ratings, even within the specific population studied, both intra- and interrater reliability checks are necessary.

APPENDIX A

INFORMED CONSENT AND SUBJECT CONTRACT

1. Purpose:

I understand that I am consenting to participation in a research study. I also understand that the purpose of this study is to provide descriptive information of the physical status of each subject tested. The parameters to be measured are: height, weight, bone size, body girths, skinfold thickness, and percent body fat.

Procedures:

I also realize that in order to obtain data for the determination of the parameters mentioned in the previous paragraph, I will participate in the following procedures, conducted between May 21, 1984 and March 15, 1985.

A. Height, weight, triceps skinfold, two bone sizes, and a variety of body girths (circumferences): shoulder, chest, abdomen, hips, thigh, biceps, forearm, wrist, knee, calf, ankle, and mid upper arm will be measured in duplicate.

B. Body composition will be evaluated by a hydrostatic (underwater) weighing method.

All measures will be obtained from each subject while she is wearing a thin one-piece bathing suit.

2. Risks and Discomforts:

To assess body composition I must be weighed both on a dry (land) scale and underwater in the diving pool at the University of Utah Natatorium. While perhaps uncomfortable for those not accustomed to water, the procedure poses no risk and will be supervised by the principal and, at times, co-investigators. The various skinfold and girth measurements; as well as height, weight, and bone diameter, present no risk.

3. Benefits:

By participating in this study I will obtain an assessment of my body composition, frame size, height, weight, upper body muscle mass, and physique. These assessments will provide me with valuable information for my own use, pertinent to my dance activities, and provide the faculty of the Ballet Department information which may assist them in guiding my career.

4. Confidentiality

I agree that the data generated from this experiment may be used for medical and scientific purposes including publication, with the understanding that my identity will not be revealed unless my express consent is granted.

5. I have been advised that I can ask questions about the project at any time. Should I have any questions or doubts, I will contact Jim Gudgeon at 534-0504 (home) or at 292-6622 (work), or Pat Eisenman, Ph.D., at 581-7929.

6. Participation in this study is voluntary. I understand that I may withdraw my consent and discontinue participation in the study at any time without prejudice. I further understand that if during any of the testing sessions I feel that I can no longer continue, regardless of the reason, I am free to terminate the session.

_____ _____

Subject's signature date

_____ _____

Witness's signature date

_____

Subject's phone number

APPENDIX B

STAGE APPEARANCE AND BALLET DANCE SKILLS RATING

I. Stage Appearance rating

	1 (poor)	2 (fair)	3 (good)	4 (very good)	5 (exceptional)
Stage Appearance					

II. Dance Skills rating

	1 (poor)	2 (fair)	3 (good)	4 (very good)	5 (exceptional)
Alignment					
Flexibility of Joints					
Muscle Strength					
Adagio Quality					
Overall Coordination					
Allegro Quality					
Pointé Work					

Total Score _____

APPENDIX C

NOTES ON EVALUATION OF BALLERINAS APPEARANCE AND DANCE SKILLS

Dancers are judged on the same things today as they were one hundred years ago. These are mainly assessments of the physique, the technique, and the style a dancer exhibits. Two major factors are the physical structure, and the "line" the body creates in space. The following are the principal components of physique and "line" considered by the ballet faculty at the University of Utah:

1. Body proportion: size, height, weight, torso in proportion to legs, girth, shape of the head, shoulders, torso, size of breasts in women, buttocks, width of the hips, length of the neck, and the axial alignment of the legs.
2. Flexibility and range of movement in the joints, especially the back, hip, knee, ankle, tarsal area, and toes.
3. The ability to outward rotate the legs at the hip socket in the extended and flexed positions.
4. The shape of the foot for pointé work.
5. Posture and alignment of the entire body.

The technical and stylistic areas judged are also somewhat affected by the dancers' structures.

The following are the artistic components of ballet technique considered by the dance faculty:

1. Movement quality and élan.
2. Stability and aplomb.
3. Musicality and coordination of all the body parts.
4. Style (classic ballet).
5. The categories of the classwork: barre, center barre, adagio, allegro, turns, etc.

Barbara Hamblin, faculty
Ballet Department
University of Utah
October, 1985

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