ANTHROPOMETRIC MEASUREMENTS OF FEMALE ADOLESCENT BALLET DANCERS

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfillment of the requirements for the degree of
MSc(Med) in the field of Biokinetics.

Johannesburg, 2012

DECLARATION

I, Tanya Lourens, declare that this research report is my own work. It is being submitted for the degree of MSc(Med) in the field of Biokinetics, at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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Signature of candidate

5th day of April 2012.

PUBLICATIONS AND PRESENTATIONS ARISING FROM THIS STUDY

This study has been orally presented, at the South African Sports Medicine Association Congress, in October 2011.

ABSTRACT

ANTHROPOMETRIC MEASUREMENTS OF FEMALE ADOLESCENT BALLET DANCERS

Introduction: Body composition assessment should be routine practice for health care professionals involved in ballet dancer health and wellness. It could serve as a tool to quantify appearance in dance in order to guide adolescent dancers towards appropriate body composition goals. The data obtained from body composition can be used to identify the "at risk dancer" and thus serve as a screening tool. Young dancers at risk to develop amenorrhea and possible osteoporoses later in life can be identified. The aim of this study was to investigate the body composition and somatotype of two groups of female adolescent ballet dancers, classified as having low – moderate training(< 10 hours per week) and those having moderate - high training(≥ 10 hours per week). The dancers who trained more or equal to 10 hours per week, were classified as Group one and the dancers who trained less than 10 hours per week, were classified as Group two.

Methods: Fifteen subjects aged 13 – 18 years from Johannesburg and 39 subjects aged 13 – 18 years from Pretoria were invited to participate and volunteered for the study. All ethical procedures were conformed to. Anthropometric measurements were taken on all subjects and the data was used to compute percent body fat, body mass index and somatotype for each subject. Subjects completed a questionnaire pertaining to their demographic information, medical history, eating habits and training habits. Descriptive and inferential statistical methods were computed in order to determine variances, standard deviations and means of the study population. Correlations between variables were also computed.

Results: The two groups differed significantly with respect to mean arm girth (flexed), mean chest girth, mean biacromial breadth as well as body mass measurements. The group that trained more had higher measures for all components tested. The somatotypes of the subjects in Group one were predominantly localized in the endo-mesomorphic and endo-ectomorphic areas. Subjects in Group two were predominantly classified as ecto-endomorph.

Conclusion: The study showed that there was no significant difference between the body composition of the group who trained less or equal to ten hours per week and the group who trained more than ten hours per week. The correlation results with respect to anthropometric data indicated that body mass, body mass index (BMI) and triceps skinfold measurements are the best measures to represent anthropometric data in female adolescent ballet dancers. The correlation results also indicated that body mass, BMI and percent body fat are not dependent on physical activity, but these variables might be more influenced by other factors, such as dietary intake.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the following individuals for their assistance with my research report:

- Professor Yoga Coopoo and Professor Demitri Constantinou for being my supervisors and for all their help, assistance and advice. I really could not have done the research report without your valuable contribution.
- Doctor Kerith Aginsky and Doctor Steve Olorunju for their assistance with the statistical analysis and interpretation of the data.
- Juanita Bouwer for her assistance with the data collection.
- Lourens de Koning for his assistance with the compilation of excel spread sheets.
- Veronica Lourens for her assistance with the final computer editing of the research report.

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CHAPTER 1

1.0 INTRODUCTION

Ballet has been viewed as both an art form and a professional sport. The physical demands of strength, flexibility, power and endurance in combination with skill and technique determines the quality of classical ballet performance (1). According to Steinberg et al (2008) (2) these factors were not sufficient to predict the performance future of dancers, but a specific body type may have been equally or more important. Due to the slender body required to meet the aesthetic standards of classical ballet (1), dancers were constantly concerned about body weight and appearance (3). As a result, dancers restricted caloric intake and followed excessive training regimes (4). This combination could lead to the development of amenorrhea and, if left untreated, the phenomenon known as the “female athlete triad” (5). This phenomenon is characterized by a group of disorders i.e. disordered eating, secondary amenorrhea and low bone mineral density. It is very common in female athletes who participate in aesthetic-acrobatic activities (5) like dance and rhythmic gymnastics (4). Dancers are therefore at increased risk to develop injuries like stress fractures (6) and long term health problems such as osteoporosis (4).

As a result, dancers and their healthcare providers are challenged to find the fine balance between adequate energy consumption (7) to maximize on-stage performance and have a healthy body. Therefore the assessment of body composition may be most useful not only to determine the optimal body composition to improve training techniques, but also to provide descriptive anthropometrical characteristics of dancers (8).

Very few studies have been done on adolescent female ballet dancers using anthropometric measurements to determine body fat percentage. However, a number of studies have been done on dancers older than 18 years of age, which documented and discussed the use of hydrostatic weighing (9), and made use of total body electrical conductivity(TOBEC) (6,10) or bio-electrical impedance analysis(BIA) (8,11) to determine percentage body fat.

Micheli et al (2005) (12) found that the use of skinfold measurements are the most practical and accurate technique to determine body composition in dancers. Skinfold measurement is also a direct method for estimating percentage body fat, is inexpensive (8) and can easily be learned and applied by most health care practitioners (11). Thus, for the purpose of this study, anthropometric measurements were used to determine body composition.

Previous studies on female ballet dancers, investigating body composition using anthropometric methods, were done on pre-professional and professional ballet dancers (1,11,12). The mean age of subjects ranged from 17 – 32 years (professional dancers), 18 – 35 years (professional dancers) and 15 – 17 years (pre-professional dancers) respectively. Hours of dancing per week ranged from 30 – 40 hours.

Steinberg et al (2008) (2) investigated the anthropometric measurements of female dancers aged 8 – 16 years. The physiques of girls training more than 7 hours per week (classified as the moderate - high group) were compared to those training less than or equal to 7 hours per week (low – moderate group). Dancers were divided into groups according to dancing intensity.

To date, only limited data is available on the body composition and somatotype of student/non-professional adolescent female ballet dancers training less than 10 hours per week. It is important to investigate the body composition of female ballet dancers aged 13 – 18 years, as the dancer's body undergoes major developmental changes during this period. As a result, dancers are very susceptible to the development of eating disorders and participation in excessive training regimes that may lead to menstrual dysfunction and long term health problems (4). To the researcher's knowledge, no South African studies have been done in this field to date.

Therefore the purpose of this study was to determine the body composition and somatotype of two groups of female adolescent ballet dancers, classified as having low – moderate (≤10 hours per week) or moderate to high (> 10 hours per week) training.

These findings can serve as guidelines in an effort to quantify appearance in dance in order to guide young dancers towards appropriate body composition goals. A dancer will be classified as having a specific somatotype, giving a true reflection of their physique, as opposed to simply being grouped according to body weight. The data can be used to identify the “at risk dancer” and thus serve as a screening tool. Young dancers at risk of developing amenorrhea and possible osteoporoses later in life may be identified.

1.1 Background of study

As part of the overall professionalization in sport, specifically women in aesthetic sports, questions have arisen pertaining to the health and wellness of this group of athletes. As stated in the introduction to this chapter, female adolescent ballet dancers could be seen as an at risk athletic population for developing specific disorders common to the art form (5). In an effort to maintain a low body weight, dancers engage in excessive training regimes from a young age. This is often in conjunction with disordered eating habits (4). As the adolescent body undergoes major developmental changes during this phase, the dancer’s body is at risk to develop menstrual cycle irregularities and possible stress fractures (6). If the body does not receive adequate nutrients in a well balanced diet, its natural healing process could become retarded (34). As a result the dancer becomes more susceptible to overtraining and the development of sports injuries.

It is thus clear that a special need exists to guide this population with regards to specific body composition goals, correct training regimes as well as nutritional advice. This can only be done if regular screening is done with regards to the anthropometric measurements of the dancers. Data should also be obtained on an annual basis pertaining to the medical history, eating habits and training regimes of the dancers. A portfolio should be created for each dancer to ensure the early detection of any risk to develop health problems.

Therefore it follows that anthropometric testing is indicated in female adolescent ballet dancers, not only pertaining to the above mentioned factors, but also due to the lack of existing published data in this field. After a thorough literature review, it became clear that there was only limited published data on the anthropometric characteristics of adolescent female classical ballet dancers. Most published data concentrated on professional adult female ballet dancers. There was not only a lack of research in this field to date, but specifically in South Africa.

1.2 Aim of study

The aim of this study was to investigate the body composition and somatotype of two groups of female adolescent ballet dancers, classified as having low – moderate training (≤10 hours per week) and those having moderate - high training (>10 hours per week) and to determine if there were any differences between the groups.

1.3 Objectives of study

- To determine the duration of training of each group of dancers.
- To determine the height, weight and body mass index (BMI) of each group of dancers classified as having low – moderate and moderate – high training according to the study by Steinberg et al (2008) (2).

- To determine the girth and breadth measurements of each group of dancers classified as either having low – moderate or moderate – high training.
- To determine the body fat percentage of each group of dancers classified as either having low – moderate or moderate – high training.
- To determine the somatotype of each group of dancers classified as either having low – moderate or moderate – high training.
- To determine the age at onset of menarche as well as the menstrual cycle regularities and irregularities as a percentage of the total number of subjects in each group of dancers, classified as either having low – moderate or moderate – high training.
- To determine the correlation coefficients of the variables tested in each group of dancers, classified as either having low – moderate or moderate – high training.
- To determine the differences between the above measures in the two groups.

1.4 Hypothesis

Adolescent ballet girls training more than ten hours per week will have a lower body fat percentage and BMI than those training less time. Dancers training more than ten hours per week will have a different somatotype compared to dancers training less time.

1.5 Limitations

The sample in this study consisted of predominantly amateur dancers. The samples in the available literature were predominantly pre-selected and included dancers that had a professional ballet career in mind. As a result comparisons could only be made on this basis, and direct comparisons could not be made.

In all questionnaire studies there are inherent limitations with respect to memory lapses and interpretations of questions, however the researcher had attempted to reduce the incidence of such situations by being present at the administration of all questionnaires.

1.6 Definitions of terms and abbreviations

The terms that will be defined in this section will lend clarity to its interpretation in this study.

1.6.1 Adenosine triphosphate (ATP)

A high-energy compound consisting of adenosine with three phosphate groups attached; the third is attached by a high energy bond. A high energy bond is a covalent bond, and when broken down energy is released. This energy is used by the cells in the body (17).

1.6.2 Adolescence

Adolescence commences at puberty, the period of sexual and physical maturation, and ends when growth is completed (17).

1.6.3 Amenorrhea

If menarche does not appear by age 16, or the cessation of menstrual function without menopause, for a duration of at least six months or more (17).

1.6.4 Body composition

The body primarily consists of three components i.e. bone, muscle and fat (15). The quantification of these components in relation to the individual's body weight has both implications for health and sports performance.

1.6.5 Body fat percentage

The proportion of the total body weight that is fat tissue expressed as a percentage. It is an expression of relative body fat (14).

1.6.6 Body mass index (BMI)

Body mass index is determined by dividing a person's body weight in kilograms by the square of their body height in meters. It is the most widely used clinical standard to estimate obesity (16).

1.6.7 Bio-electrical impedance analysis (BIA)

In Bio-electrical impedance analysis (BIA) four electrodes are attached to an individual's hands and feet, two per limb either ipsilaterally or contralaterally. The individual is at rest in the supine position. A low amperage electrical current is passed between the electrodes and the resistance to the current is recorded. The ability to conduct the electrical current is determined by the amount of water and electrolytes in the various body tissues. The flow of the electrical current is easier in fat free tissue than in fat tissue, because there is more water and electrolytes in fat free tissue (20).

1.6.8 Bone breadth measurements

Bone breadth measurements are used to determine body frame size and can be used to determine body type. Measurements are taken by means of narrow or broad blade calipers as well as smaller sliding calipers, depending on the area of the body measured (15).

1.6.9 Bone mineral density (BMD)

Bone mineral density (BMD) is defined as the relative value of bone mineral per measured bone area, expressed either as grams per centimeter squared ($g.cm^{-2}$) or milligrams per centimeter cubed ($mg.cm^{-3}$), depending on the technology used to assess the area. BMD is clinically used to provide an operational definition of osteopenia and osteoporosis (20).

1.6.10 Classical ballet

Classical ballet is the most formal of the ballet styles. It puts great emphasis on the method and execution of movement and therefore adheres to traditional ballet technique. A distinctive feature of ballet is the continuous external rotation of the thighs from the hip, referred to as "turnout". The foundation of classical ballet consists of five basic arm and leg positions, all performed with the turnout. There are at least seven styles of training in classical ballet, the most common being Vaganova method (Russian), Cecchetti method (Italian), Royal Ballet School and Royal Academy of Dance methods (English), as well as the Balanchine method (American) (21).

1.6.11 Dual energy x-ray absorptiometry (DEXA)

In this process, two x-rays are generated at two different energies. The differential attenuation of the x-ray beam at these two energies are used to calculate the bone mineral content and soft tissue composition during a full body scan. As a result, the fat and fat free content of the body can be estimated (14).

1.6.12 Girth measurements

Measurements that record the size of cross-sectional and circumferential dimensions of the body. Measurements are taken by means of a tape measure (15).

1.6.13 Heath-Carter method of somatotyping

The Heath-Carter anthropometric somatotype method (13) will be used to determine the somatotype of each subject.

1.6.14 Hydrodensitometry

Determining body composition through the calculation of body density (20). The individual's body density is calculated by dividing body mass by body volume. Body volume is determined by hydrostatic or underwater weighing, while the individual's body mass is his/her scale weight (16).

1.6.15 Maximal oxygen uptake (VO_2max)

The highest amount of oxygen an individual can take in and utilize to produce ATP aerobically while breathing air during heavy exercise (20).

1.6.16 Menarche

The uterine cycle begins with the menarche, in other words, the first menstrual period at puberty. The onset of menarche is usually at age 11-12, but can vary according to each individual (17).

1.6.17 Menstrual cycle

The uterine cycle, or menstrual cycle, is a repeating series of changes in the structure of the endometrium. The uterine cycle averages 28 days in length, but it can also range from 21 to 35 days in healthy women of reproductive age. The cycle consists of three phases: menses, proliferative phase and the secretory phase (17).

1.6.18 Oligomenorrhea

Oligomenorrhea refers to infrequent and irregular menstrual bleeding (18),or when bleeding occur at intervals longer than 35 days (16).

1.6.19 Oogenesis

Known as ovum production. Oogenesis commences before a women’s birth, accelerates at puberty and ends at menopause (17).

1.6.20 Osteoporosis

A condition of porosity and decreased bone mineral density that is defined as a bone mineral density greater than 2.5 SD below values for young, normal adults (20).

1.6.21 Puberty

The onset of puberty is the period when sexual maturation starts. The age at which puberty begins varies from 8-13 years. During this period, many body systems alter their activities in response to circulating sex hormones and to the presence of growth hormone, thyroid hormones and adrenocortical hormones. As a result, gender specific differences in structure and function develop (17).

1.6.22 Royal Academy of Dance (RAD)

The English method or style of training in classical ballet (21).

1.6.23 Skinfold caliper

An instrument used to measure the thickness of a fold of skin in order to estimate the amount of body fat (15).

1.6.24 Skinfold measurement

The measurement of subcutaneous fat by means of skinfold thickness (14). The thickness of double folds of skin and subcutaneous adipose tissue, at specific sites on the body, are measured by means of a skinfold caliper (15).

1.6.25 Somatotyping

The technique of somatotyping is used to determine body shape and composition. The somatotype of an individual is defined as the quantification of the present shape and composition of the human body. It is expressed in a three number rating representing endomorphy, mesomorphy and ectomorphy components respectively, always in the same order (13).

1.6.26 Thelarche

The onset of breast formation in females (19).

1.6.27 Total body electrical conductivity (TOBEC)

During this process, individuals lie supine on a motorized carriage. The body is then transported headfirst through the electromagnetic coil of the machine and a whole body conductivity measurement is made. As a result, the volume of the distribution of the conductive elements in the body is determined i.e. the fat free mass (10).

1.7 Abbreviations

- Adenosine triphosphate: ATP
- Body mass index: BMI
- Bone mineral density: BMD
- Bio-electrical impedance analysis: BIA
- Centimeter: cm
- Dual energy x-ray absorptiometry: DEXA
- Kilogram: kg
- Maximal oxygen uptake: VO_2max
- Millimeter: mm
- Royal Academy of Dance: RAD
- Total body electrical conductivity: TOBEC

CHAPTER 2

2.0 REVIEW OF LITERATURE

2.1 Introduction

Recently, the art of ballet developed from a recreational entertainment into a professional sport. As a result, more emphasis was placed on skill and technique, as these factors have been said to determine the quality of classical ballet performance. It also became evident that a specific body type was required in order to excel as a ballerina, thus emphasizing the slender body required to meet the aesthetic standards of classical ballet (1). Therefore dancers dramatically increased the number of hours they trained and restricted caloric intake (2) in order to achieve a very low body weight, thus conforming to the aesthetic demands of the sport. Dancers became an at risk group of athletes in terms of developing eating disorders, secondary amenorrhea and low bone mineral density (5).

As a result, the scientific investigation into the body composition of female classical ballet dancers, spiked the interest of health care professionals in the field of sports medicine. It became evident that routine health and wellness screening in this group of athletes were of utmost importance (12). Therefore the scientific enquiry, with regards to the anthropometric measurements of female classical ballet dancers, lead to the need for further research in this field.

After a thorough literature review, it became clear that there was only limited published data on the anthropometric characteristics of adolescent female classical ballet dancers. Most published data concentrated on professional adult female ballet dancers. Other recent studies on the anthropometric development of dancers also seemed limited, as they often generalized from professional older dancers to younger dancers (2). On the other hand, not only the need for further research, but also the major developmental changes that occur in the female adolescent body, could also warrant an investigation into the body composition in this group of dancers.

2.2 Stages of athletic development in children and young adolescents

Children and young adolescents all grow and mature at different rates. Their bones, muscles, organs as well as nervous systems grow at different rates and these growth rates also differ from stage to stage of development. These stages of development are also influenced by the hormonal changes during puberty, which has a profound effect on the physiological responses to exercise as well as physical performance. As a result, the development of each stage will closely dictate the physiological and performance capabilities of the individual (19). Therefore coaches should consider individual performance differences and training potential when designing a training programme, in order to minimize the risk of injury. This can best be achieved through a process known as periodization of long-term training. During periodization, training programmes are divided into small segments of time, in order to ensure a more gradual increase in training intensity. The end result will be a more effective training programme. The four stages of athletic development for young athletes as described by Bompa (2000) (19) serve as a guideline in this regard.

2.2.1 Stage 1: Initiation stage – 6 to 10 years (Pre-pubertal stage)

In the pre-pubertal stage of development, the emphasis should be on the overall athletic development of gross motor abilities and not sport-specific performance. Training regimes should be based on low- intensity activities as body tissues are very susceptible to injury. Although ligaments are strengthening, bone ends are still cartilaginous and in the process of calcifying. Therefore most children are not capable of dealing with the physical as well as the psychological demands of high-intensity training or organized competitions. The coach should encourage participation in a variety of different sporting activities with the emphasis on fun (19).

Training programmes should be creative, varied and focused on developing predominantly the aerobic system, as children have a limited ability to adapt physiologically and biologically. Most importantly, children should develop adequate flexibility, coordination and balance to prepare them for the next stage.

2.2.2 Stage 2: Athletic formation – 11 to 14 years (Puberty)

This stage also marks the clinical expression of puberty, which usually commences in girls between the ages of 10 and 11 years and lasts for 4 to 5 years (23). Puberty is not only characterized by the development of reproductive function but also alterations in body composition, size, function as well as bone maturation. All these changes are the result of the secretion of the sex hormone oestrogen. As a result girls experience an increase in fat accumulation in terms of their body fat percentage as well as the onset of breast formation (thelarche). The greater fat content present in females relative to males is already evident at age 11. This can have a detrimental effect on the performance of weight-bearing activities, as the added adipose tissue can serve as an additional inert load that must be transported (24). Menarche occurs approximately 2 years later. The timing and tempo of pubertal development varies tremendously between individuals. It is of utmost importance that coaches recognize the effect which the hormonal changes at puberty have on the physiological responses to exercise and the physical performance of adolescents (23).

The marked increase in the production of oestrogenic and androgenic hormones during puberty is responsible for changes in the physiologic and performance fitness during puberty. Puberty strongly affects aerobic fitness, as seen in the longitudinal changes with regards to the absolute values for maximal oxygen consumption(VO_2 max). These values increase during puberty due to an increase in body size, specifically in the dimensions of the heart, lungs, muscles as well as the circulatory system (23). After age 14 in girls, peak VO_2 plateau (14). Sexual maturation has no influence on the development of VO_2 max, other than the changes it induces in body size and composition (23). Studies investigating the influence of puberty on muscle strength and anaerobic fitness were predominantly done on males. Therefore no concrete conclusions could be made, from the literature, with regards to females (23). Clearly coaches should be sensitive to developmental changes that the female body undergoes during this stage of athletic development and should adjust their conditioning programmes accordingly.

In the athletic formation stage, athletes should refine and automate the basic sporting skills acquired in stage one. Drills should be designed to develop fundamental sporting tactics and strategies with the emphasis on further skill development. Training intensity should be slowly increased and exercises which improve general core strength should be emphasized. Aerobic capacity should still be developed, as a good endurance base will enable athletes to cope effectively with the demands of training and competition in the next stage. Moderate anaerobic training should be introduced, as it will help the athletes adapt to high-intensity anaerobic training which is essential in most sports (19).

Coaches should understand that variances in individual performance may be the result of differences in growth. Athletes going through a rapid growth spurt may lack coordination during the execution of specific drills. At such times, coaches should pay closer attention to developing motor abilities and sporting skills, as oppose to focusing on performance and winning (19).

2.2.3 Stage 3: Specialization – 15 to 18 years (Post-puberty and adolescence)

The post-puberty and adolescence stage of development should emphasize high performance development in a specific sport. Athletes should aim to master the majority of the technical aspects related to their sport. Training volume and intensity should be increased to facilitate progressive improvements in the dominant motor abilities for the specific sport. The majority of training drills and exercises should be sport specific, functional and should also incorporate game-specific tactical training drills. The aerobic and anaerobic capacity of athletes should be increased to an even higher level than before. Athletes should be exposed to competitions as often as possible, so that by the end of this stage, athletes are competing frequently at a senior level. As a result most of the significant changes in training will take place during this stage (19).

2.2.4 Stage 4: High performance – 19 years and older (Maturity)

Athletes aged 19 years and older are considered sexually mature with regards to sexual maturation and development. A well designed conditioning and training programme based on a long term development plan will ultimately lead to high performance at this stage. It is well known that exceptional performance results achieved during the initiation, athletic formation or specialization stages do not necessarily correlate with high performance results as a senior competitor. Most athletes are only really successful after they have reached athletic maturation, which is often only years after sexual maturation has been reached (19).

By respecting the physiological developmental changes which characterize each of the stages of athletic development, coaches should be able to train young athletes with a minimal risk of injury. These principles of training can be applied to any sport, including ballet, and if applied correctly, should ultimately lead to performance at an elite level.

2.3 Stature, body mass and body mass index (BMI)

The aesthetic nature of classical ballet requires a specific body type (1). As a result dancers are forced to maintain the correct body weight for their height. This is not only important to meet the aesthetic demands of the sport, but also to make partnering between males and females easier. Low levels of fat on body composition are also regarded as beneficial, as it makes the execution of ballet movements easier, as well as to reduce overload on weight bearing joints (24).

An important early study by Clarkson et al (1989) (1), was also relevant to this study, as the aim of the study was to assess and determined the anthropometric measurements of the members of a professional ballet company and the students who were enrolled at the Company's school. The anthropometric measurements of 83 female adolescent ballet dancers and 15 professional dancers were taken. The dancers attended the Boston Ballet summer programme and the Boston Ballet Company respectively. The adolescent dancers were divided into three groups according to their skill level as determined by the Boston Ballet School.

Thirty one dancers were in the least advanced level (group A), 38 were in the moderately advanced level (group B) and 14 were in the most advanced level (group C). The mean age of the three groups of dancers were: group A 15.1(±1.4), group B 16.0(±1.7) and group C 17.2(±1.4) years. The mean height of the dancers in each group was 160.6cm(±5.7), 163.5cm(±4.5) and 165.7cm(±7.1) respectively. The body mass of the three groups of dancers was 47.7kg(±5.9), 49.5kg(±4.1) and 51.1kg(±5.9) for each of the three groups. The dancers trained a mean number of hours per week in “ballet class” of 12.0(±4.9), 14.2(±5.8) and 13.1(±8.9) hours respectively. They spent a further mean number of hours per week in rehearsals of 7.5(±3.4), 10.4(±6.6) and 9.8(±7.7) for each group.

Similar results were found in the study by Hergenroeder et al (1991) (6). The 112 female dancers in the study had a mean age of 15.0(±2.0) years and participated for a mean of 16(±12) hours per week in dance training. Their mean height was 159.2cm(±6.4). They had a mean body mass of 44.8kg(±5.7).

As evident from the studies by Clarkson et al (1989) (1) and Hergenroeder et al (1991) (6), girls in ballet schooling have a low body weight for their height. This ratio between height and weight is termed the body mass index (BMI).

Body mass index (BMI) has been used worldwide to classify obesity (16). The World Health Organization classified BMI as <18.5 as underweight, 18.5 – 24.9 as normal weight, 25 – 25.9 as overweight and > 30 as obese (25). Various studies have been done investigating the BMI of female adolescent ballet dancers.

Stokic et al (2005) (5) compared the BMI of 30 female ballet dancers (mean age 17.4(±2.01) years) to a control group consisting of 30 non-athletic girls (mean age 18.01(±1.3) years). The mean height of the ballet dancers were 166.55cm(±6.07) and the mean body weight was 51.48kg(±5.01). The BMI of 18.56(±1.53) for the ballet dancers vs 19.96(±2.12) for the control group, indicated a significantly lower BMI in the ballet dancers than in the control group. Similarly, Quintas et al (2003) (26) found the BMI of 33 ballet dancers (mean age 16.2(±2.0) years) to be 18.7(±1.1). The mean height of the ballet dancers were 162.80cm(±4.3) and the mean body weight was 49.5kg(±3.9). When Quintas et al (2003) (26) compared the BMI of the dancers to 26 basketball players, 15 skiers and 90 sedentary females (all subjects had a mean age of 16.2 – 17.2 years), the dancers had the lowest BMI's.

Furthermore, Da Silva & Bonorino (2007) (24) found similar results when they compared the BMI of 11 female ballet dancers (age 13 – 16 years) to 11 female contemporary dancers of the same age. The mean height of the ballet dancers was 164cm(±0.05) and the mean body weight was 53.27kg(±5.64). The ballet dancers had a mean BMI of 19.92(±2.73) and the contemporary dancers had a mean BMI of 20.23(±2.14). It is thus clear that adolescent female ballet dancers border the underweight category when looking at their body mass index. Da Silva & Bonorino (2007) (24) concluded that most ballet dancers adapt these low levels of body composition in order to excel in their art form as well as to reduce overload on their joints.

Although BMI has been viewed as a good predictor of body fat mass (which is used in the diagnosis of underweight, overweight and obesity), numerous studies have concluded that discrepancies existed between BMI and body fat (5). BMI does not distinguish between fat, muscle or bone mass. Furthermore, although BMI is a reliable measure of fatness, an adolescent's body fat percentage can change by -3 to +7 without any change in BMI. In addition, the study by Stokic et al (2005) (5) also suggested a lower reliability with regards to BMI values in the prediction of risk for menstrual disorders compared to body fat. They also found a stronger negative correlation between body fat and menstrual cycle duration compared with BMI.

2.4 Somatotype

Body composition has been identified as a component of physical fitness (9). It can be expressed in terms of an individual's somatotype. The somatotype gives a quantification of the present shape and composition of the body (13), and is therefore of utmost importance to athletes involved in aesthetic sports. It is expressed in a three number rating representing endomorphy, mesomorphy and ectomorphy components respectively, always in the same order (13).

Endomorphy is the relative fatness, mesomorphy the relative musculoskeletal robustness and ectomorphy is the relative linearity or slenderness of the individual's physique. For example, a 3-5-2 rating is recorded. These numbers give the magnitude of each of the three components. Ratings on each component of 0.5-2.5 are considered low, 3-5 are moderate, 5.5-7 are high and 7.5 and above are very high (27). Theoretically there is no upper limit to the ratings, and values of 12 or more can occur in very rare instances. The components are rated relative to stature, therefore the somatotype is independent of, or normalized for stature.

The somatotype has been used:

- to describe and compare athletes of various levels of competition

- to characterize physique changes during growth, aging and training
- to compare the relative shape of men and women
- as a tool in the analysis of “body image” (13).

The Heath-Carter method of somatotyping is the most commonly used today (13).

Claessens et al (1987) (3) investigated the somatotype of 22 female adolescent ballet dancers with a mean age of 12.7 years. All dancers participated in dance training for at least 13 hours per week and their mean age for starting ballet training was 8.5 years. The somatotype of the group was anthropometrically determined according to the Heath-Carter method. The somatotypes of the dancers were predominantly in the endo-ectomorphic and meso-ectomorphic areas of the somatochart. The mean somatotype was 2.8-2.6-5.1.

In contrast, the study by Evans et al (1985) (22), found the somatotype of a group of 15 dance majors with a mean age of 23.2 years as predominantly in the endo-mesomorphic area of the somatochart. The dancers had participated in dance for 7.7 years and participated in dance training for 13.2 hours per week. The somatotype of the group was anthropometrically determined according to the Heath-Carter method. The mean somatotype of the dancers was 3.43-3.07-2.97. The somatotype of the dancers was compared to a group of gymnasts with a somatotype of 2.61-4.39-2.61.

The dancers had a lower muscularity component, but a similar ectomorphic component when compared to the group of gymnasts. The mesomorphic component of the dancers were lower due to the fact that gymnasts have more muscular development of the upperbody. As a result gymnasts have an increased muscle mass. Gymnasts need good upperbody strength to perform bar routines, whereas dancers hardly need upperbody strength to perform the majority of their dance routines. As a result dancers often ignore the development of the upperbody.

In general, it was concluded that dancers have a balanced somatotype (22). In comparison to an ectomorph, the high endomorphic component often seen amongst ballet dancers could be as a result of an increased body fat percentage. A similarity between the endomorphic and mesomorphic components can often be seen, due to the well defined muscularity in the lower extremities of the dancer. The ectomorphic component would give dancers a more linear appearance. If all the three components are well balanced, the dancer will appear linear, with a small frame as well as with well defined features. A good balance between fatness, muscularity and linearity is of utmost importance to contribute to the aesthetic appearance of ballet dancers (22).

2.4.1 Girth measurements

The three girth measurements that were of importance to this study were upper arm girth flexed, chest girth as well as maximum calf girth. These girth values were used to determine the somatotype of each subject. As duration and intensity of training influence the development of muscle mass, it was also important to note the number of hours spent in training by the dancers in each study reviewed.

The only study which measured the upper arm girth of female adolescent ballet dancers was the study by Clarkson et al (1989) (1). The mean arm girths(flexed) for each of the groups were group A 22.9cm(±1.7), group B 23.4cm(±1.4) and group C 22.8cm(±1.5). The dancers trained a mean number of hours per week in "ballet class" of 12.0(±4.9)(group A), 14.2(±5.8)(group B) and 13.1(±8.9)(group C) hours respectively. They spent a further mean number of hours per week in rehearsals of 7.5(±3.4)(group A), 10.4(±6.6)(group B) and 9.8(±7.7)(group C) for each group.

The studies by Hergenroeder et al (1993) (7) and Castelo-Branco et al (2006) (4) measured the chest girths in ballet dancers. The dancers in the study by Hergenroeder et al (1993) (7) had a mean age of 14.9(±2.1) years and participated for a mean of 15.6(±10.9) hours per week in dance training. The dancers had mean chest girth measurements of 74.5cm(±4.3). In the study by Castelo-Branco et al (2006) (4) dancers had a mean age of 14.8(±1.7) years and trained for a mean number of 15.5 hours per week. The dancers in this group had mean chest girth measurements of 80cm.

The mean maximum calf girth measurements documented in the study by Clarkson et al (1989) (1) were: group A 33.1cm(±2.2), group B 33.5cm(±1.6) and group C 33.8cm(±1.8). The dancers in the study by Hergenroeder et al (1993) (7) had mean maximum calf girth measurements of 32.0cm(±2.2). It appears that both research findings were similar with different groups of ballet dancers of similar age.

2.4.2 Bone breadth measurements

The three bone breadth measurements that were of importance to this study was biacromial bone breadth, humerus bone breadth and femur bone breadth. These bone breadth values were used to determine the somatotype of each subject.

The study by Clarkson et al (1989) (1) also investigated the somatotypes of adolescent ballet girls by means of the Heath Carter method. As a result, it made a valuable contribution to this study, in terms of the bone breadth values that could have been compared to the values obtained in this study.

The three groups of dancers had the following mean biacromial bone breadth measurements: group A 32.0cm(±2.1), group B 33.5cm(±1.8) and group C 34cm(±2.7). The three groups of dancers had the following mean humerus bone breadth measurements: group A 6.1cm(±3.4), group B 5.7cm(±0.5) and group C 5.8cm(±0.3). The three groups of dancers had the following mean femur bone breadth measurements: group A 7.8cm(±0.5), group B 7.9cm(±0.3) and group C 7.9cm(±0.4).

2.5 Body composition

Body composition consists of two components: fat mass and lean body mass or fat-free mass. Fat mass is expressed in terms of the percentage of the total body mass that is composed of fat, whereas lean body mass refers to all tissues in the body that is not fat (16). The measurement of percent body fat and lean body mass in dancers, could serve as a method to quantify appearance in dance. Dancers could then be guided towards appropriate body composition goals. Dancers would then have a more accurate reflection of their physique instead of only relying on body weight. Body weight alone does not take proportions of muscle and fat into account (11). Percent body fat could also be used to determine the minimal body weight a female dancer should aim for. As a result excessive weight loss could be reduced as well as the use of unhealthy weight loss methods (28). Performing measurements of body composition on dancers have been shown to be a good marker for dance health and adequate nutrition (12).

2.5.1 Percentage body fat

Due to the low body weight and fat mass, often recorded amongst female ballet dancers, the clinical implications and problems related to these measurements should be emphasized. Low body fat could contribute to the development of hypothalamic dysfunction and as a consequence to primary and secondary amenorrhea (28,10). Thus the accurate measurement of body fat should be a priority for health professionals involved in dancer health.

Various methodologies have been used for the assessment of body composition among ballet dancers. Although hydrodensitometry has been considered the “gold standard” for body composition assessment (9) it has many limitations. Body fat measured by hydrodensitometry is often under-estimated, because the technique is sensitive to variation in bone density (10). It has been reported that professional ballet dancers have bone densities of the tibia and fibula 23-28% greater compared to matched controls. Thus hydrodensitometry will underestimate body fat in subjects with increased density.

It has also been reported that not all subjects could complete the repeated underwater weighing trials, pulmonary residual air volume had to be estimated and intestinal gas could not be measured. All these factors can contribute to measurement error (10).

Bio-electrical impedance analysis (BIA) has also been used in the physical assessment of dancers. This technique also has various limitations. Differences in skin conductivity, bone density, food intake as well as the natural variations in total body water levels between individuals (11) can all constitute confounding variables. BIA is also impractical for actively training dancers, as manufacturers recommend no heavy exercise 12 hours before testing, no food for several hours prior to testing and normal ingestion of fluids before testing.

Total body electrical conductivity (TOBEC) as a means to measure body composition has the following limitations: uniform conductivity, constant cross-sectional area, homogenous cylindrical conductor, known length (8) as well as sensitivity to body geometry (6).

Although dual x-ray absorptiometry (DXA) is an accurate method to determine bone and soft tissue composition (8), it is still considered an expensive means of testing and it is not accessible to most dance schools and companies.

Futhermore, Eliakim et al (2000) (28) investigated the use of four different methods to determine the percentage body fat of a group of 59 female ballet dancers with a mean age of 15.5(±0.1) years. Estimations of body fat by means of skinfold measurements, BIA and body mass index(BMI) was compared to the estimation of body fat by dual-energy X-ray absorptiometry(DXA). The percent body fat documented by means of skinfold measurements was 24.0(±0.01) and by means of BIA was 20.9(±0.01). Body fat percentage by DXA was 22.5(±0.01) and by BMI was 21.6(±0.3). The results of this study indicated a significant positive correlation between all four methods of body fat assessment and no difference between DXA and the other three methods. As DXA is a validated method to evaluate body composition in ballet dancers, it was suggested that both BIA and skinfold measurements be used as field based techniques in the assessment of body fat in this population. These two methods are not as expensive as DXA and much more accessible to most health care practitioners.

Similarly, Kautedakis et al (1996) also found that the most used field estimate of body composition was the skinfold assessment. This method is not only a direct method for estimating body fat percentage, but also inexpensive(8). Chmelar et al (1998) (11) and Wilmerding et al (2003) (9) also agreed that this method was the most practical and accurate technique for determining body composition in dancers.
Total levels of body fat for health should range from 20 – 32 percent for females (25). Most female athletes, specifically those competing in endurance sports or aesthetic-acrobatic activities, have body fat values ranging from 12 – 16% (5). Micheli et al (2005) (12) investigated the changes in pre-season and post-season body

composition values of professional female ballet dancers with a mean age of 22(±3.8) years. Pre-season dancers weighed 51.6kg (±4.6) and post-season 50.4kg(±4.5). Dancers had danced at a professional level between one and twenty years. Anthropometric measurements were used to determine the dancer's pre- and post-season fat percentages. Equations by Jackson and Pollock were used to calculate body fat percentage. Pre-season, dancers had a mean fat percentage of 12.8(±2.7) and post-season a mean fat percentage of 11.5(±2.1).

Eliakim et al (2000) (28) also used the skinfold method to determine the percent body fat of 59 female adolescent ballet dancers with a mean age of 15.5(±0.1) years. The mean percent body fat was 24(±0.01). Siri's equation was used to calculate percent body fat. The mean height of the dancers were recorded as 161cm(±0.7) and the mean body weight as 51.5kg(±0.8). The dancers in this study were recruited from two art high schools in Israel. They were not at an elite level, but was national art high school level. All subjects participated in dance for at least 15 hours per week. None of the subjects participated in other sports.

Clearly ballet dancers (mostly professional dancers) strive to maintain a low body fat, as they believe it would maximize their on-stage performance (8). These sportswomen are those with the highest prevalence of secondary amenorrhea from sports training, as the critical amount of body fat leading to amenorrhea is below 17%. On the other hand, a fat percentage of 22 is required for regular menstrual cycles (30). This "critical body fat hypothesis" as an explanation for the prevalence of hypothalamic amenorrhea, as proposed by Frisch (1994) (30), has not been substantiated by longitudinal research. In fact, women with normal body fat levels may also experience hypothalamic amenorrhea (19).

Two theories have been proposed to explain the onset of secondary amenorrhea as a result of sports training (19). The first theory, known as the exercise stress hypothesis, states that the physical stress of exercise could be the cause for a loss in normal menstrual function. As a result, cortisol and other stress hormones triggered by exercise, provide negative feedback on the hypothalamus and thus the production of gonadotropin-releasing hormone(GnRH) is lowered. The consequence of this mechanism is the depression of luteinizing hormone(LH) production, oestrogen levels, oogenesis and menses.

The second theory, known as the energy availability hypothesis, states that a negative caloric balance created by the energy demands of exercise, could cause a shut down in the gonadotropin-releasing hormone(GnRH) generator. This theory is also applicable to nonathletes who suffer from malnutrition and as a result secondary amenorrhea (19).

In conclusion, highly trained female adolescents suffering from primary or secondary amenorrhea, should be recognized as an at risk population as the associated presence of hypo-oestrogenemia may increase their risk of impaired bone mineralization.

2.5.2 Lean body mass

Lean body mass constitute 55-96% of the total body weight of an individual. It consists of more or less 48% muscle, 16% bone, 14% skin, 9% blood and 13% organs (20). As bone and other lean tissues are relatively stable, any change in lean body mass is usually the result of a change in muscle mass (29). For most athletes in sports which require strength, power and muscular endurance, maximizing lean body mass is desirable as it enhances performance (16). This is also true for ballet dancers, although a dancer should not increase lean body mass at the expense of agility. For most dancers being light is a priority, as it makes the execution of ballet movements easier as well as partnering between males and females(24). As a result, female ballet dancers often present with below normal levels of muscular strength, which increases their risk for lower-extremity injuries (29). Claessens et al (1987) (3) also suggested that the low levels of body weight, often measured in female adolescent ballet dancers, are the result of a light skeletal frame in conjunction with a below average amount of muscle tissue. Furthermore, a low lean body mass could also contribute to a low bone mineral density(BMD), as the factors which positively affect BMD are: moderate physical activity, total body and/or lean body mass as well as dietary calcium intake (31). Therefore ballet dancers have an increased risk for low levels of bone mineral density, as they often engage in chronic strenuous exercise in conjunction with practices of malnutrition, which could lead to hormonal imbalances, like hypoestrogenemia (31).

However, Van Marken Lichtenbelt et al (1995) (31) investigated the BMD of 24 ballet dancers with a mean age of 22.6 years, to a control group with a mean age of 21.4 years. They concluded that the dancers had a relatively high BMD as well as a high-muscle-low-fat body composition. The highest BMD was found in the legs (1.239g/cm^2) and spines (1.223g/cm^2) of the dancers. These sites were also the sites of maximum skeletal stress in the body, as ballet dancing predominantly stresses the lower extremities in weight bearing. As the dancers engaged in physical activity for 20 to 48 hours per week, it was concluded that the high BMD values measured at the weight bearing sites of the body (legs and spine), could be attributed to the high levels of physical activity of the group.

It is thus clear that ballet dancers need specific guidelines in order to maintain a healthy body composition, but simultaneously maximize their on stage performance. Dancers should understand that decreasing total body weight as well as percentage body fat, should not be at the expense of lean body mass.

2.6 Menarche and menstrual cycle

Results by Stokic et al (2005) (5) confirmed that ballet dancers had both lower values of BMI and percent body fat than non-athletic girls of the same age. It thus follows that these dancers can develop menstrual cycle irregularities as well as a delay in the onset of menarche. According to Castelo-Branco et al (2006) (4), primary amenorrhea is defined as the non-appearance of menarche up to 16 years of age and late menarche when the first period appeared after 14 years.

The mean weight at menarche, of United States and European populations, has been shown to be approximately 46 – 47 kg. A body fat percentage of 22% also correlates with the onset of menarche as well as regular menstrual cycles (30). Intense physical exercise has been shown to affect the onset of menarche (18). Age at onset of menarche as well as the regularity of menstrual cycles, is therefore dependent on various factors, and thus different for each individual.

Castelo-Branco et al (2006) (4) investigated the influence of intensive training on 115 adolescent girls aged 12 – 18 years. The group consisted of 38 ballet dancers and 77 sedentary girls. The average age of the ballet dancers were 14.8(±1.7) years. The control group had an average age of 14.8(±1.6) years. The ballet dancers had been practicing dance for an average period of 7.2 years and for an average of 15.5 hours per week.

The average age at menarche was 12.4 years for the dancers and 12 years for the control group. The girls who started training at least 1 year before menarche, had an average age at menarche of 12.6 years and those who started training after menarche had an average age at menarche of 12.1 years. It was concluded that the age of menarche was delayed by an average of 4 months in the dancers. It could thus be said that intense physical exercise before menarche delays menarche.
In this study by Castelo-Branco et al (2006) (4), 58% (n = 21) of the dancers had regular menstrual cycles, 35% (n = 13) presented with oligomenorrhea and 8% (n = 2) had amenorrhea. On the other hand, 75% of the control group had regular

menstrual cycles (n = 57), 14% (n = 11) had oligomenorrhea and the remaining 11% (n = 8) had other cycle anomalies.

Furthermore, a study by Quintas et al (2003) (26) determined the average age at menarche, of 33 ballet dancers with a mean age of 16.2(±2.0) years, to be an average of 13.3(±1.05) years. The dancers also spent an average of 25.2 hours per week in dance training.

Similar results were found by Bonbright (1989) (32) who investigated 32 ballet dancers with a mean age of 16.4 years. The dancers had been practicing dance for an average period of 9.2 years and for an average of 20 hours per week. The mean age for menarche was 13.5 years. Fourteen dancers (44%) had regular menstrual cycles, while the remaining 18 (56%) experienced menstrual dysfunction.

It is thus clear that young ballet dancers spent an excessive amount of hours per week in dance training. This could be considered a reason for a delay in menarche (4) as well as the irregularity of menstrual cycles. Intense physical exercise during the adolescent years could also have an effect on the skeletal growth and development of the young female dancer (39).

2.7 Nutrition

In order to maintain a lean body mass, caloric intake must not exceed caloric expenditure (33). In order to achieve this, many female dancers resort to a radical restriction in their dietary intake (34) as well as making incorrect food choices in the process.

According to Snell (1998) (35) most ballerinas do not know how to make correct food choices, especially in balancing the intake between carbohydrates and protein. Furthermore, dancers have a tendency to skip meals or to eat only limited amounts at mealtimes. In a study by Castelo-Branco et al (2006) (4), 76% of the dancers did not eat four daily meals. As a result dancers resort to unhealthy snacking for example consuming pastries, candy and soft drinks. Consuming large amounts of these simple carbohydrates only provides energy for a limited period, leaving the dancer feeling tired and depleted of energy.

In an attempt to correct for hypocaloric consumption and the lack of proper nutritional knowledge, ballet dancers often take vitamin and mineral supplements. Often these supplements do not contain the proper amount or type of nutrients needed by the active adolescent (35). The developmental changes that take place from puberty to adulthood creates a demand for nutrients, specifically those involved in skeletal growth and development for example calcium, phosphorus and vitamin D, while iron is important for sexual maturity (36).

More so, active females have a larger amount of lean body tissue compared to adipose tissue. The metabolic demand of lean muscle mass is higher than fat mass and therefore the body’s nutrient requirements are higher (36). A study by Benson et al (1989) (34) showed that only 50% of adolescent ballet dancers consumed enough calories to support normal growth, but even more so healing. As a result these dancers take longer to recover from injury. The study by Van Marken Lichtenbelt et al (1995) (31) has also shown that low dietary intake, during early childhood and adolescence, could also have an effect on age of menarche, menstrual cycle regularity as well as bone mineral density. A low bone mineral density could make dancers more susceptible to the development of stress fractures and in conjunction with inadequate nutrition, could also cause a delay in the healing process.

In conclusion, research suggests that dancers should be advised to rather increase their caloric expenditure, in an effort to maintain a low body weight, as oppose to resort to caloric restriction (37). Schantz and Astrand (1984) (37) showed that classical ballet should be viewed as predominantly intermittent exercise. Thus the endurance or aerobic component of ballet training is not adequate to expend large amounts of calories. Therefore, dancers should incorporate an endurance activity in their training programmes to compensate for the non-endurance component of ballet training (32).

Lastly, dancers should be seen as a group of athletes requiring specific education related to nutrition, as the constant emphasis that is placed on thinness could make them susceptible to the development of eating disorders (38).

2.8 Intense physical exercise and skeletal growth, development and maturation

Various factors determine whether exercise during childhood and adolescence is beneficial or detrimental. This may depend on the type and intensity of the exercise or whether exercise is undertaken before puberty when skeletal growth is not sex hormone dependent. Excessive exercise undertaken around puberty may be associated with hypogonadotropic hypogonadism, delayed puberty and reduced bone density. Whether the exercise is weight bearing or the area being loaded contains large amounts of trabecular bone is also important, as trabecular bone is more sensitive to hypogonadism. A reduced body weight also plays a role, as it is a risk factor for osteoporosis (39).

Reduced body weight, percentage body fat as well as body mass index also contributes to a delayed maturation in female athletes in aesthetic sports. Intensive training coupled with a high frequency, continued over many years, in conjunction with high levels of psychological stress and modified nutrition also have been shown to impact skeletal growth and sexual maturation (40).

2.9 Hours spent per week in ballet training

The high technical demands of classical ballet require dancers to train intensely and for prolonged periods on a daily basis. This rigorous training regime is started at a young age, as it takes many years to master this art form.

The dancers in the study by Hergenroeder et al (1991) (6) participated for a mean of 16(±12) hours per week in dance training and had a mean age of 15.0(±2.0) years. Similar results were obtained by Hergenroeder et al in 1993. The dancers in this study had a mean age of 14.9(±2.1) years and participated for a mean of 15.6(±10.9) hours per week in dance training. Likewise, Quintas et al (2003) (26) determined the mean hours per week in dance training were 25.2(±4.9) for a group of dancers with a mean age of 16.2(±2.0) years.

As evident from the literature (6, 7, 26), adolescent dancers could devote between 15-26 hours per week to dance training. As most of these dancers had a professional career in mind, very few of them participated in other sporting activities besides ballet and other related dance forms.

CHAPTER 3

3.0 METHODS OF STUDY

In this chapter the researcher will describe the methods and procedures undertaken during the experimental work of this study.

3.1 Study design

Cross sectional descriptive study, using evaluation of anthropometric measurements as well as a questionnaire to obtain information about this population.

3.2 Site of study

The study was conducted at the Waterkloof High School in Pretoria as well as the National School of the Arts in Johannesburg.

3.3 Study population

Subjects were recruited from the Waterkloof High School in Pretoria as well as the National School of the Arts in Johannesburg. These schools are representatives of the art schools in the Gauteng province.

3.4 Sampling

Female adolescent ballet dancers aged 13-18 years.

3.5 Selection and recruitment of subjects

A total number of 70 subjects were invited from the National School of the Arts in Johannesburg to participate in the study. Only fifteen subjects arrived for testing. All fifteen subjects adhered to the inclusion criteria of the study. A total number of 50 subjects were invited from the Waterkloof High School in Pretoria to participate in the study. Thirty nine subjects arrived for testing. All 39 subjects adhered to the inclusion criteria of the study.

All 54 subjects arrived with signed informed consent forms, which were signed by the participants and their guardians. Subjects were asked to complete a questionnaire pertaining to their demographic information, eating habits, medical history as well as their training habits. Anthropometric measurements were also performed on all subjects.

3.5.1 Inclusion and exclusion criteria

Inclusion criteria:

- Females
- Age 13-18 years
- Must participate in classical ballet training
- Must be of a Vocational Graded Level as per the guidelines of the Royal Academy of Dance. Must train a minimum of two hours per week in classical

ballet as per guidelines set out by the Royal Academy of Dance for dancers studying for the Vocational Graded Examinations.

- All subjects must have no injuries severe enough to exclude them from their usual training regime.

Exclusion criteria:

- Males
- Not aged 13-18 years
- Not participating in classical ballet training.
- Not at a Vocational Graded Level as per the guidelines of the Royal Academy of Dance. Training less than a minimum of two hours per week in classical ballet as per guidelines set out by the Royal Academy of Dance for dancers studying for the Vocational Graded Examinations.
- Injuries severe enough to exclude them from their usual training regime.
- Subjects who exercise with intense physical effort (exercising for fitness or skills in a sport for more than two hours a day, at least three days a week) other than classical ballet or dance.

3.6 Measuring tools and instruments

All testing measurements were standardized, using the guidelines as recommended by the American College of Sports Medicine (25).The researcher did all the testing personally with the assistance of a qualified Biokineticist. The assistant was trained with respect to the testing methods used in the study. At all the testing sessions, both the researcher and the assistant was present.

3.6.1 Anthropometric measurements were determined for each group of dancers according to the study by Steinberg et al (2008) (2).

Measurements were taken according to the standard methods described by Lohman et al (1988) (15) of:

Table 3.1 Measurements and instruments used

Measurement	Instrument
Standing height	Free standing anthropometer
Body weight	Digital scale Carmen model A125
Upper arm girth flexed	Steel tape measure
Chest girth	Steel tape measure
Calf girth	Steel tape measure
Biacromial breadth	Steel spreading caliper
Biepicondylar humerus breadth	Steel spreading caliper
Biepicondylar femur breadth	Steel spreading caliper
Triceps skinfold	Harpenden skinfold caliper
Subscapular skinfold	Harpenden skinfold caliper
Suprailiac skinfold	Harpenden skinfold caliper
Medial calf skinfold	Harpenden skinfold caliper

3.6.1.1 Standing height (stature)

Purpose: Stature is an indicator of general body size and of bone length. It is important in screening in the interpretation of weight (15).

Apparatus required: A free standing anthropometer was used. It consisted of a vertical graduated rod and a moveable rod that was brought onto the head of the subject.

Description of test: The subjects were barefoot or had thin ballet tights on and wore tight leotards in order to see the positioning of the body clearly. The subjects stood on the floor with the vertical graduated rod at a right angle to the floor. The weight of the subjects was distributed evenly over both feet with their heads positioned in the Frankfort horizontal plane. The arms hanged freely by the sides next to the trunk, with the palms facing the thighs. The subject's heels were placed together, with both heels touching the vertical graduated rod. The scapulae and buttocks of the subjects were placed in contact with the vertical graduated rod.

Subjects were asked to inhale deeply while maintaining a fully erect posture without altering the load on the heels. The moveable rod was brought onto the most superior point on the subject's head with sufficient pressure to compress the hair. The measurement was recorded to the nearest 0.1 mm.

Scoring: The standing height of each subject was recorded in centimeters (cm) to the nearest 0.1 mm.

Precautions: The researcher had to ensure the correct positioning and alignment of all subjects' heads i.e. in the Frankfort horizontal plane. It was also noted that all subjects had no shoes on. All measurements had to be recorded while subjects inhaled. These were the only three confounding factors in the measurement of standing height.

3.6.1.2 Body weight

Purpose: Body weight is a composite measure of total body size. It is important in screening in order to determine obesity or malnutrition (15), which could have an influence on an athlete's performance.

Apparatus required: A digital scale (Carmen model A125) was used to record the subject's weight.

Description of test: Subjects stood completely still and unsupported in the centre of the scale platform. Body weight was evenly distributed between both feet. Clothing were standardized for all subjects i.e. ballet tights and leotards. Body weight was recorded to the nearest tenth of a kilogram.

Scoring: The body weight of each subject was recorded to the nearest tenth of a kilogram (kg).

Precautions: It was ensured that all subjects adhered to the standardized clothing as well as the correct distribution of their body weight while standing on the scale platform.

Other confounding variables that could not be controlled was the food and fluid intake of each subject prior to testing, as well as the precise time of day that the body weight was recorded.

3.6.1.3 Upper arm girth flexed

Purpose: Arm girth flexed is an indicator of muscle and adipose tissue development, in other words an index of body energy stores and protein mass (15).

Apparatus required: A steel tape measure was used to record the measurement.

Description of test: The right shoulder was flexed to 90° and the elbow to 45° while the subject stood erect. As all subjects wore leotards, the skin on the upper arm was exposed during the measurements. The hand was clenched and the elbow flexors and extensors were maximally contracted. The measurement was taken with a steel tape measure over the greatest girth of the arm. The measurement was recorded to the nearest millimeter.

Scoring: The measurement was recorded to the nearest millimeter (mm).

Precautions: It was ensured that all subjects adhered to the standardized clothing, in order to expose the skin on the upper arm during the recording of all measurements. When positioning the steel tape measure, all testers had to position the tape measure correctly around the arm. The tape measure only touched the skin of the arm and was not pulled to tight as to compress the soft tissue. Incorrect technique (pulling the tape measure to tight) could result in smaller girth measurements. The skin had to be free of perspiration to prevent friction between the skin and the tape.

3.6.1.4 Chest girth

Purpose: Chest girth is used as an indicator of frame size (15).

Apparatus required: A steel tape measure was used to record the measurement.

Description of test: The subject stood erect with feet shoulder width apart. The arms were abducted slightly to position the steel tape measure around the chest. The arms were lowered to the sides and the chest circumference was measured at the level of the fourth costosternal joint. The measurement was made in a horizontal plane at the end of a normal expiration. The measurement was recorded to the nearest millimeter.

Scoring: The measurement was recorded to the nearest millimeter (mm).

Precautions: It was ensured that all subjects adhered to the standardized clothing. When positioning the steel tape measure, all testers had to position the tape measure correctly around the chest. The tape measure had to be in the correct horizontal position, both in front and at the back of the subject. The tape measure only touched the chest and was not pulled to tight as to compress the soft tissue. Incorrect technique (pulling the tape measure to tight) could result in smaller girth measurements.

3.6.1.5 Calf girth

Purpose: Calf girth can be used in combination with calf skinfolds to provide estimates of cross-sectional muscle and adipose tissue areas of the calf. It is also an important predictor of body composition (15).

Apparatus required: A steel tape measure was used to record the measurement.

Description of test: Calf girth was measured in a standing position on the right side of the body. The subject stood as erect as possible with body weight evenly distributed over both feet. The measurement was taken over the widest part of the calf with a steel tape measure. The measurement was recorded to the nearest millimeter.

Scoring: The measurement was recorded to the nearest millimeter (mm).

Precautions: It was ensured that all subjects adhered to the standardized clothing. When positioning the steel tape measure, all testers had to position the tape measure correctly around the calf. The tape measure only touched the calf and was not pulled to tight as to compress the soft tissue. Incorrect technique (pulling the tape measure to tight) could result in smaller girth measurements. The skin had to be free of perspiration to prevent friction between the skin and the tape.

3.6.1.6 Biacromial breadth

Purpose: Biacromial breadth is measured as an index of body frame. It is also used in somatotyping (15).

Apparatus required: A steel spreading caliper was used to record the measurement.

Description of test: Biacromial breadth was measured standing on a step behind the subject. The subject stood with heels together and arms hanging next to sides. The shoulders were in a relaxed position, pointing slightly downwards and forwards. The researcher stood directly behind the subject and applied the blades of the spreading calipers firmly to the most lateral borders of the acromial processes. The width was read to the nearest 0.5 mm.

Scoring: The width was recorded to the nearest 0.5 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The leotard worn by subjects ensured that the shoulders were uncovered in order to expose the acromial processes. The shoulders had to be positioned correctly i.e. in a relaxed position and not pulled back. If the measurement is taken with the shoulders pulled back, the measurement is reduced by two to three centimeters. Firm pressure was also applied in taking the measurement in order to decrease the influence of soft tissue.

3.6.1.7 Biepicondylar humerus breadth

Purpose: Biepicondylar humerus breadth has been used as a measure of frame size as well as an index of skeletal mass (15).

Apparatus required: A steel spreading caliper was used to record the measurement.

Description of test: The right shoulder was flexed to 90° and the elbow to 45° while the subject stood erect. The back of the subject's hand faced the researcher. The researcher stood in front of the subject and palpated the lateral and medial epicondyles of the humerus. The spreading calipers were held at a slight angle to the epicondyles and the distance between the epicondyles was recorded, exerting firm pressure. The width was read to the nearest 0.5 mm.

Scoring: The width was recorded to the nearest 0.5 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The leotard worn by subjects ensured that the elbows were uncovered in order to expose the epicondyles. Firm pressure was also applied in taking the measurement in order to decrease the influence of soft tissue.

3.6.1.8 Biepicondylar femur breadth

Purpose: Biepicondylar femur breadth has been used as a measure of frame size as well as an index of skeletal mass. It is commonly used in somatotyping to determine the mesomorphic or musculoskeletal component (15).

Apparatus required: A steel spreading caliper was used to record the measurement.

Description of test: The subject was seated with the right knee flexed to 90°. The researcher stood in front of the subject and placed the spreading calipers over the most medial and most lateral aspects of the femoral epicondyles. The caliper was positioned diagonally downward and the distance between the epicondyles was recorded, exerting firm pressure. The width was read to the nearest 0.5 mm.

Scoring: The width was recorded to the nearest 0.5 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The tights worn by subjects ensured that the knees were clearly visible in order to expose the epicondyles. In order to decrease the influence of soft tissue, the knee was placed in a flexed position and firm pressure was also applied in taking the measurement.

3.6.1.9 Triceps skinfold

Purpose: The triceps skinfold closely correlates with percentage body fat and total body fat. It is useful in order to determine fat patterning. In combination with other skinfold measurements it can be used to predict total body fat (15).

Apparatus required: A Harpenden skinfold caliper was used to record the measurement.

Description of test: The triceps skinfold was measured in the middle of the posterior side of the arm, over the triceps muscle, at the point midway between the lateral projection of the acromion process of the scapula and the inferior margin of the olecranon process of the ulna. The level of measurement was determined by flexing the elbow to 90° and measuring the distance between the acromial process and the inferior border of the olecranon process of the ulna. A plastic tape measure was placed with its zero mark on the acromion and stretched along the upper arm all the way below the elbow. The midpoint was marked on the lateral side of the arm.

The measurement was taken standing upright with the right arm hanging loosely next to the side and the palm facing anteriorly. Standing behind the subject the researcher picked the triceps skinfold up with the left thumb and index finger, approximately 1cm proximal to the marked point. The calipers were applied to the skinfold at the marked level. The skinfold was measured to the nearest 0.1 mm. Triplicate measurements were taken and the mean value was used.

Scoring: The skinfold was recorded to the nearest 0.1 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The leotard worn by subjects ensured that the upper arm was uncovered in order to expose the triceps muscle. All skinfolds were taken approximately 1cm proximal to the site at which the skinfold was to be measured, in order to prevent the pressure from the fingers affecting the measured value. Care was taken to only elevate skin and adipose tissue and not a part of the underlying muscle as well. All skinfolds were kept elevated by the left hands' thumb and index finger until the measurement was completed.

3.6.1.10 Subscapular skinfold

Purpose: The subscapular skinfold thickness is used to measure subcutaneous adipose tissue and skin thickness on the posterior aspect of the upper body. In combination with other skinfold measurements it can be used to predict total body fat (15).

Apparatus required: A Harpenden skinfold caliper was used to record the measurement.

Description of test: The subscapular skinfold was taken on the right side of the body, just inferior to the inferior angle of the scapula. The skinfold was picked up on a diagonal, inclined infero-laterally approximately 45° to the horizontal plane in the natural cleavage lines of the skin. The subject stood erect with arms hanging next to sides. The skinfold was measured to the nearest 0.1 mm. Triplicate measurements were taken and the mean value was used.

Scoring: The skinfold was recorded to the nearest 0.1 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The leotard worn by subjects ensured that the upper back was uncovered in order to expose the scapulae. All skinfolds were taken approximately 1cm proximal to the site at which the skinfold was to be measured, in order to prevent the pressure from the fingers affecting the measured value. Care was taken to only elevate skin and adipose tissue and not a part of the underlying muscle as well. All skinfolds were kept elevated by the left hands’ thumb and index finger until the measurement was completed.

3.6.1.11 Suprailiac skinfold

Purpose: In combination with other skinfold measurements it can be used to predict total body fat (15).

Apparatus required: A Harpenden skinfold caliper was used to record the measurement.

Description of test: The suprailiac skinfold was measured in the midaxillary line superior to the iliac crest on the right side of the body. An oblique skinfold was taken just posterior to the midaxillary line following the natural cleavage lines of the skin. The measurement is aligned inferomedially at 45° to the horizontal. The subject stood erect with arms hanging next to the sides and feet together. The skinfold was measured to the nearest 0.1 mm. Triplicate measurements were taken and the mean value was used.

Scoring: The skinfold was recorded to the nearest 0.1 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The leotard worn by subjects ensured that the area superior to the ilium was easily accessible. All skinfolds were taken approximately 1cm proximal to the site at which the skinfold was to be measured, in order to prevent the pressure from the fingers affecting the measured value. Care was taken to only elevate skin and adipose tissue and not a part of the underlying muscle as well. All skinfolds were kept elevated by the left hands' thumb and index finger until the measurement was completed.

3.6.1.12 Medial calf skinfold

Purpose: It is useful in order to determine fat patterning in the lower body. In combination with other skinfold measurements it can be used to predict total body fat (15).

Apparatus required: A Harpenden skinfold caliper was used to record the measurement.

Description of test: The subject was seated with the right knee flexed to 90° and the right foot on the floor. The level of the maximum calf circumference was marked on the medial side of the calf. A skinfold parallel to the long axis of the calf on its medial aspect was raised. The skinfold was measured to the nearest 0.1 mm. Triplicate measurements were taken and the mean value was used.

Scoring: The skinfold was recorded to the nearest 0.1 mm.

Precautions: It was ensured that all subjects adhered to the standardized clothing. The tights worn by subjects ensured that the medial part of the calf was easily accessible. All skinfolds were taken approximately 1cm proximal to the site at which the skinfold was to be measured, in order to prevent the pressure from the fingers affecting the measured value. Care was taken to only elevate skin and adipose tissue and not a part of the underlying muscle as well. All skinfolds were kept elevated by the left hands' thumb and index finger until the measurement was completed.

3.6.2 Heath-Carter method

The Heath-Carter method was used to determine the somatotype of each subject. A computer programme Labtests was used to calculate the somatotype of each subject.

3.6.3 Body mass index (BMI)

The body mass index of each subject was calculated by means of the following equation:

$$BMI = \frac{\text{weight (kg)}}{\text{height (m}^2\text{)}}$$

The body weight of each subject in kilograms was divided by the square root of the subject's standing height in meters (20).

3.6.4 Percentage body fat

Percentage body fat was calculated according to the equation devised by Slaughter et al in 1988. This skinfold equation is recommended for predicting body fat in children 8-18 years of age, as it takes into consideration the use of a multicomponent approach to body composition and account for the chemical immaturity of children. The equation is:

$$\% \text{ Body Fat} = 0.610(\text{triceps skinfold} + \text{calf skinfold}) + 5.1$$

3.6.5 Data collection methods

All subjects were physically tested by the researcher and scores were recorded. All subjects were required to complete a questionnaire.

3.6.6 Ethics

- All subjects received an information sheet with regards to the study (Appendix 8.7).
- All subjects acquired parental consent. Informed consent and child assent forms were signed by all subjects (Appendix 8.8 and 8.9).
- The researcher applied to the Human Research Ethics Committee of the University of the Witwatersrand for research clearance (Appendix 8.2).
- A permission letter was obtained from the Waterkloof High school in Pretoria and the National School of the Arts in Johannesburg (Appendix 8.5 and 8.4).

- A permission letter was obtained from the Gauteng Department of Education to conduct the research (Appendix 8.3).

3.6.7 Statistical analysis

Descriptive statistical methods were computed in order to determine variability, which included means and standard deviations of the study population. Subjects were divided into Group one, classified as having moderate to high (> 10 hours per week) or Group two, low – moderate (≤ 10 hours per week) training. Inferential statistical methods were computed to determine whether there were statistical significant differences between the groups studied. The two group independent t-test generated this data. Pearson's correlation coefficients were computed amongst all the variables in each of the two groups. The level of significance was set at 5%. A computerized statistical programme Stata 11 was used to analyze the data.

CHAPTER 4

4.0 RESULTS

The total number of hours spent weekly on physical activity and ballet training for each group of dancers will be presented. The results obtained from the anthropometric measurements performed on the two groups of dancers will also be presented. Any significant differences between the two groups, with regards to the measurements as well as number of hours spent on physical activity and ballet training will be identified. The somatotypes of each group will be presented as a percentage of the total number of subjects in that group. The mean age at onset of menarche in the two groups will also be presented. The menstrual cycle regularities and irregularities, as a percentage of the total number of subjects in each group, will also be identified. The significant correlations in each group will also be presented.

Table 4.1 Age, body mass, stature, body mass index and body fat percentage (n=54)

	Group1 (>10 hrs training per week) (n=35)	Group 2 (≤10 hrs training per week) (n=19)	p value
Age (years)	16.09 (±1.44)	15.47 (±1.68)	0.19
Body mass (kg)	56.31 (±8.73)	51.79 (±6.60)	0.04 *
Stature(cm)	163.80 (±7.40)	160.63 (±8.58)	0.18
Body mass index (kg/m^2)	20.92 (±2.34)	20.16 (±2.96)	0.34
Body fat (%)	22.27 (±3.83)	21.18 (±3.74)	0.32
Total hours of physical activity per week	14.64(±4.42)	8.12(±1.54)	<0.0001*
Total hours of ballet training per week	6.64(±2.73)	3.83(±1.91)	0.0003*

*Significant level at the 5% level

All the measurements fall within the normal limits for their age group (Table 4.1). The results show no significant difference between the two groups with regard to age, stature, body mass index and body fat percentage. However, a significant difference (p=0.04) was noted with regards to body mass between the two groups. Subjects in Group one were significantly heavier than subjects in Group two.

The subjects were divided into two groups. Group one did more than ten hours per week of physical activity and was classified as having moderate–high training. Group two did less or equal to ten hours per week of physical activity and was classified as having low–moderate training. Group one spent significantly(p<0.0001) more time participating in physical activity than Group two on a weekly basis. Group one also spent significantly(p=0.0003) more hours per week on ballet training in comparison to Group two.

Table 4.2 Arm girth flexed, chest girth and calf girth (n=54)

	Group1 (n=35)	Group 2 (n=19)	p value
Arm girth flexed (cm)	25.83 (±1.95)	24.24 (±2.22)	0.01 *
Chest girth (cm)	82.71 (±5.48)	78.91 (±5.19)	0.02 *
Calf girth (cm)	34.35 (±2.37)	33.21 (±2.31)	0.09

*Significant level at the 5% level

All the measurements fall within the normal limits for their age group (Table 4.2). There was a significant difference(p=0.01) in the arm girths (flexed) between the two groups. Subjects in Group one had significantly bigger arm girths than subjects in Group two. The same was found for the chest girth measurements. Subjects in Group one had significantly(p=0.02) bigger chest girth measurements than subjects in Group two.

Table 4.3 Biacromial breadth, humerus breadth and femur breadth (n=54)

	Group1 (n=35)	Group 2 (n=19)	p value
Biacromial breadth (cm)	35.68 (±1.97)	34.31 (±2.99)	0.05 *
Humerus breadth (cm)	6.03 (±0.37)	5.85 (±0.29)	0.07
Femur breadth (cm)	8.61 (±0.55)	8.40 (±0.48)	0.18

*Significant level at the 5% level

All the measurements fall within the normal limits for their age group (Table 4.3). There was a significant difference(p=0.05) in the biacromial breadths between the two groups. Subjects in Group one had significantly bigger biacromial breadth measurements than subjects in Group two.

Table 4.4 Somatotypes as a percentage of the total number of subjects in each group

	Group1 (n=35)	Group 2 (n=19)
Meso-endomorph	6 (17.14%)	3 (15.79%)
Meso-ectomorph	2 (5.71%)	1 (5.26%)
Endo-mesomorph	12 (34.29%)	3 (15.79%)
Endo-ectomorph	8 (22.86%)	3 (15.79%)
Ecto-endomorph	6 (17.14%)	6 (31.58%)
Balanced-endomorph	1 (2.86%)	1 (5.26%)
Balanced-ectomorph	0	2 (10.53%)

The somatotypes of the subjects in Group one were predominantly localized in the endo-mesomorphic (34.29%, n=12) and endo-ectomorphic (22.86%, n=8) areas (Table 4.4). Six subjects were in each of the meso-endomorphic (17.14%) and ecto-endomorphic (17.14%) areas respectively. Only two subjects were classified as meso-ectomorph (5.71%) and one subject as a balanced-endomorph (2.86%).

Six subjects in Group two were in the ecto-endomorphic (31.58%) area. Another three subjects were in each of the meso-endomorphic (15.79%), endo-mesomprphic (15.79%) and endo-ectomorphic (15.79%) areas respectively. Only two subjects were in the balanced-ectomorphic (10.53%) group. One subject was in each of the balanced-endomorph (5.26%) and meso-ectomorph (5.26%) groups respectively.

Table 4.5 Mean age at onset of menarche in the two groups

	Group 1(n=32)	Group 2 (n=18)	p value
Age at onset of menarche (years)	13.06(±1.27)	12.81(±1.53)	0.53

*Significant level at the 5% level

The mean age at onset of menarche for Group one was 13.06 years and 12.81 years for Group two (Table 4.5). No significant difference was found between the two groups.

The data obtained from the questionnaire with regards to the age at onset of subject's menstrual cycles were not answered clearly by all subjects. For this reason, the answers from four subjects had to be omitted from this section. Two of the subjects did not answer the question and two had not reached menses at the time of testing. Therefore the total number of subjects, used to calculate this specific result, in each group was: 32 in Group one and 18 in Group two.

Table 4.6 Menstrual cycle regularities and irregularities as a percentage of the total number of subjects in each group

	Group 1(n=32) Regular cycles	Group 1(n=32) Irregular cycles	Group 2(n=18) Regular cycles	Group 2(n=18) Irregular cycles
Menstrual cycle (%)	50	50	56	44

Fifty percent of the subjects in Group one had regular menstrual cycles and fifty percent did not (Table 4.6). In Group two 56% of the subjects had regular menstrual cycles and 44% had irregular menstrual cycles.

The data obtained from the questionnaire with regards to the regularity of subject's menstrual cycles were not answered clearly by all subjects. For this reason, the answers from four subjects had to be omitted from this section. Two of the subjects gave unclear answers and two had not reached menses at the time of testing. Therefore the total number of subjects, used to calculate this specific result, in each group was: 32 in Group one and 18 in Group two.

Table 4.7 Significant correlations in Group one and bodymass (n=35)

Parameter	Correlation Coefficient	Significance
Height	0.69	0.0005*
Body mass index (BMI)	0.82	0.0000*
Triceps skinfold	0.69	0.0005*
Subscapular skinfold	0.58	0.0330*
Medial calf skinfold	0.57	0.0393*
Supraspinale skinfold	0.62	0.0078*
Body fat percentage	0.67	0.0012*
Arm girth	0.80	0.0000*
Chest girth	0.87	0.0000*

*Significant level at the 5% level

The highest correlations were found between bodymass and chest girth, arm girth as well as an expected result BMI (Table 4.7). The other results also show significance, however at lower correlations. They were all significant at the 5% level.

Table 4.8 Significant correlations in Group one and BMI (n=35)

Parameter	Correlation Coefficient	Significance
Triceps skinfold	0.76	0.0000*
Subscapular skinfold	0.68	0.0008*
Supraspinale skinfold	0.59	0.0222*
Medial calf skinfold	0.62	0.0087*
Body fat percentage	0.73	0.0001*
Arm girth	0.92	0.0000*
Chest girth	0.80	0.0000*
Calf girth	0.78	0.0000*
Femur breadth	0.60	0.0166*

*Significant level at the 5% level

The highest correlations were found between BMI and arm girth as well as chest girth (Table 4.8). The other results also show significance, however at lower correlations. They were all significant at the 5% level.

Table 4.9 Significant correlations in Group one and triceps skinfold (n=35)

Parameter	Correlation Coefficient	Significance
Subscapular skinfold	0.75	0.0000*
Supraspinale skinfold	0.79	0.0000*
Medial calf skinfold	0.77	0.0000*
Body fat percentage	0.94	0.0000*
Arm girth	0.72	0.0002*
Chest girth	0.64	0.0038*

*Significant level at the 5% level

The highest correlation was found between triceps skinfold and body fat percentage (Table 4.9). The other results also show significance, however at lower correlations. They were all significant at the 5% level.

Table 4.10 Significant correlations in Group two and bodymass (n=19)

Parameter	Correlation Coefficient	Significance
Arm girth	0.83	0.0015*
Chest girth	0.94	0.0000*
Calf girth	0.92	0.0000*

*Significant level at the 5% level

The highest correlation was found between bodymass and chest girth as well as calf girth (Table 4.10). The other result also show significance, however at a lower correlation. They were all significant at the 5% level.

Table 4.11 Significant correlations in Group two and triceps skinfold (n=19)

Parameter	Correlation Coefficient	Significance
Medial calf skinfold	0.78	0.0117*
Body fat percentage	0.95	0.0000*
Arm girth	0.74	0.0389*

*Significant level at the 5% level

The highest correlation was found between triceps skinfold and body fat percentage (Table 4.11). The other results also show significance, however at lower correlations. They were all significant at the 5% level.

Table 4.12 Correlations between Group one and total hours of physical activity per week (n=35)

Parameters	Group 1 > 10 hrs per week	Significance
Bodymass vs training hours	0.28	0.62
BMI vs training hours	0.13	1.00
Body fat percentage vs training hours	-0.03	1.00

*Significant level at the 5% level

No significant correlations were found between bodymass, BMI, body fat percentage and the total hours of physical activity per week for the dancers in Group one (Table 4.12).

Table 4.13 Correlations between Group two and total hours of physical activity per week (n=19)

Parameters	Group 2 ≤ 10 hrs	Significance
Bodymass vs training hours	0.18	1.00
BMI vs training hours	0.22	1.00
Percent bodyfat vs training hours	0.08	1.00

*Significant level at the 5% level

No significant correlations were found between bodymass, BMI, body fat percentage and the total hours of physical activity per week for the dancers in Group Two (Table 4.13).

CHAPTER 5

5.0 DISCUSSION

This study showed that a null hypothesis is true, because there was no significant difference between the body composition of the group which trained less or equal to ten hours per week and the group which trained more than ten hours per week.
In this chapter the results obtained in this study will be discussed. The results pertaining to the total number of hours spent weekly on physical activity for each group of dancers will be discussed and compared to the related literature. The same will be done with the results obtained from the anthropometric measurements performed on the two groups of dancers. The somatotypes of each group will be presented and compared to the literature. The mean age at onset of menarche as well as the menstrual cycle regularities and irregularities in each of the two groups will be discussed and related to the literature. Lastly, the significant correlations between all the measured variables in each of the two groups will be discussed and compared to the literature.

The mean total number of hours trained on a weekly basis, for each of the two groups, is stated in Chapter four. According to the findings in the literature, the dancers in this study trained fewer hours per week than in published studies. The dancers in the study by Hergenroeder et al (1991) (6) had a mean age of 15.0(±2.0) years and participated for a mean of 16(±12) hours per week in dance training. Similar results were obtained by Hergenroeder et al in 1993. The dancers in this study had a mean age of 14.9(±2.1) years and participated for a mean of 15.6(±10.9) hours per week in dance training. Likewise, Quintas et al (2003) (26) determined the mean hours per week in dance training were 25.2(±4.9) for a group of dancers with a mean age of 16.2(±2.0) years.

The dancers in these studies were clearly pre-professional as they spent a large portion of their week on ballet training. Adolescent dancers devote between 17-23 hours per week to dance training (1). In contrast to these findings, it was evident that the dancers in this study were at an amateur level with regards to classical ballet. They did ballet training in conjunction with other dance forms as well as different sporting activities.

A significant difference($p<0.0001$) was also found in the mean total number of hours spent on dance training on a weekly basis, between the two groups. This indicated that the groups were truly different and did not have an effect on the results obtained from the anthropometric measurements.

The mean age, body mass and standing height for the two groups are illustrated in Table 4.1. The mean number of hours subjects participated in training, on a weekly basis, were also discussed in Chapter 4. It was observed that there was a significant difference in body mass between the two groups. This could be due to a higher lean body mass in the Group one dancers, as a result of the amount of hours they trained per week. It was shown by Van Marken Lichtenbelt et al (1995) (31) that dancers belong to a high-muscle-low-fat group as a result of the amount of physical activity that they do. Dancers in Group one were also slightly taller, which could also have contributed to the difference in body mass between the two groups.

The age, height and body mass of the dancers in this study were compared to the three groups of dancers in the study by Clarkson et al (1989) (1). The dancers in this study had similar ages and height as the dancers in the study by Clarkson et al (1989) (1). However, the dancers in this study had a larger body mass. The body mass, of the three groups of dancers in the study by Clarkson et al (1989) (1), was 47.7kg(±5.9), 49.5kg(±4.1) and 51.1kg(±5.9) respectively. The dancers trained a mean number of hours per week in "ballet class" of 12.0(4.9), 14.2(5.8) and 13.1(8.9) hours respectively. They spent a further mean number of hours per week in rehearsals of 7.5(3.4), 10.4(6.6) and 9.8(7.7) for each group. It was clear that these dancers trained a substantial number of hours more than the dancers in this study. This could be a possible explanation for their smaller bodymass.

This study was compared to the study by Hergenroeder et al (1991) (6). The 112 female dancers in the study had a mean age of 15.0(±2.0) years and participated for a mean of 16(±12) hours per week in dance training. Their mean height was 159.2cm(6.4). The age, height and hours per week in training is therefore very similar to the values measured in this study. On the other hand, the dancers in the study by Hergenroeder et al (1991) (6) had a much smaller body mass. They had a mean body mass of 44.8kg(±5.7). This difference in body mass could be attributed to the fact that the dancers from the Hergenroeder et al (1991) (6) study, was pre-selected based on their ability to do classical ballet. The subjects were recruited from a group of dancers that were selected nationwide to join a summer dancing programme at the Houston Ballet Academy. As a result, these dancers already had the perfect body type to excel as a ballerina.

It is therefore clear that the dancers in this study spent fewer hours per week in training and were of a different skill level to the dancers in the reported studies. It could also be argued that the dancers in these studies were pre-selected for their specific body type and as a result performed better as classical ballet dancers. It could be a possibility that these student dancers had a professional career in mind and therefore trained harder and for longer periods. The opposite seems to be true for the dancers in this study. These dancers were student dancers at a ballet school who took ballet as a subject at the school only. Ballet seemed to have been done only at an amateur level and the dancers probably will never reach professional status. This could be a reason for the differences in anthropometric measurements between those found in this study and the findings in the literature. This will be considered when evaluating the other results related to this study.

The body mass index (BMI) for the two groups can be found in Table 4.1. There was no significant difference between the two groups in terms of their respective body mass indices. As the age and standing height were similar between the two groups, the only factor that could have had an influence on the BMI between the two groups, was the amount of training done by each group. The total amount of training was significantly different($p<0.0001$) therefore it was surprising that no difference between the two groups could be found. It could be concluded that BMI is not predominantly influenced by the amount of training, but maybe more so by a decrease in body mass and percentage body fat.

Similar BMI values to this study were reported by Da Silva & Bonorino (2007) (24). Da Silva & Bonorino (2007) (24) compared the BMI of 11 female ballet dancers (age 13 – 16 years) to 11 female contemporary dancers. The ballet dancers had a mean BMI of 19.92 and the contemporary dancers had a mean BMI of 20.23. Very few studies were found on adolescent female ballet dancers supporting these findings. The majority of the literature reported much lower BMI values for this population group.

Stokic et al (2005) (5) compared the BMI of 30 female ballet dancers (mean age 17.4 years) to a control group consisting of 30 non-athletic girls (mean age 18.01 years). The BMI (18.56 vs 19.96) were significantly lower in the ballet dancers than in the control group. Similarly, Quintas et al (2003) (26) found the BMI of 33 ballet dancers (mean age 16.2 years) to be 18.7. When he compared the BMI of the dancers to 26 basketball players, 15 skiers and 90 sedentary females (all subjects had a mean age of 16.2 – 17.2 years), the dancers had the lowest BMI's.

It is thus clear that adolescent female ballet dancers border on the underweight category (BMI < 18.5) when looking at their body mass index. Most ballet dancers adopt these low levels of body composition in order to excel in their art form as well as to reduce overload on their joints (24).

It could be reasoned that the BMI of the dancers in this study was higher than the values reported in the study by Stokic et al in 2005, due to the fact that the dancers in this study had a higher body mass and were also shorter. In comparison with the study by Quintas et al (2003) (26), the dancers in the two studies were of similar height, but the dancers in this study had a larger body weight and thus had a higher BMI.

Table 4.1 illustrates the mean body fat percentage for each group of dancers. No significant difference was found between the two groups with regard to their body fat percentage. Although there was a significant difference($p<0.0001$) between the two groups with regards to the mean total amount of exercise done on a weekly basis, it was clear that, in this study, the amount of training done, did not influence the body fat percentage of the two groups.

In contrast, Micheli et al (2005) (12) found that there was a significant change in the body composition of female ballet dancers (mean age 22) over the course of a professional ballet season. Pre-season, dancers had a mean fat percentage of 12.8 and post-season a mean fat percentage of 11.5%. They concluded that the observed changes were due to an increase of physical activity over the season without a compensatory increase in caloric intake. It was also a possibility that the female dancers deliberately decreased their caloric intake during a ballet season.

In this study, the caloric intake of the dancers was not monitored over a specific period of time. Only general questions pertaining to their dietary habits were answered in the questionnaires. Thus the possibility exist that the dancers did not expend more energy than they consumed. As a result, the amount of training done would have no effect on their body fat percentage.

Another argument that could explain the fact that there was no difference between the two groups, is the intensity of the exercise. Schantz and Astrand (1984) (37) showed that classical ballet should be viewed as predominantly intermittent exercise. Thus the endurance or aerobic component of ballet training is not adequate to expend large amounts of calories. Therefore the intensity of the exercise could have been too low to have had an effect on the dancer's body fat percentage. Dancers should be encouraged to incorporate an endurance activity in their training programmes to compensate for the non-endurance component of ballet training (32).

In comparison to this study, similar body fat percentage values were found by Eliakim et al (2000) (28). In the study by Eliakim et al (2000) (28), the skinfold method was also used to determine the percent body fat of 59 female ballet dancers with a mean age of 15.5 years. The mean percent body fat was 24. The similarities between the study by Eliakim et al (2000) (28) and this study, with regards to the body fat percentage values found, could be due to the similarity of the sample that was tested. Both samples consisted of adolescent dancers that participated in physical activity for a similar amount of hours per week and at the same skill level. The samples also were of similar age, height and body mass.

Apart from the above mentioned study, very few studies have been done on adolescent female ballet dancers using anthropometric measurements to determine body fat percentage. Most studies focused on dancers older than 18 years of age, which documented and discussed the use of hydrostatic weighing (9), and made use of total body electrical conductivity(TOBEC) (6,10) or bioelectrical impedance(BIA) (8,11) to determine body fat percentage. The majority of these studies found that professional female ballet dancers had very low body fat percentage levels. These levels were often as low as 12 – 16% (5,12).

Clearly professional female ballet dancers strive to maintain a low body fat, as they believe it will maximize their on-stage performance (8). These sportswomen are those with the highest prevalence of amenorrhea, as the critical amount of body fat leading to amenorrhea is below 17%. On the other hand, a fat percentage of 22 is required for regular menstrual cycles (30).

Table 4.2 illustrate the mean girth measurements of the two groups. There was a significant difference(p=0.01) in the arm girths(flexed) between the two groups. Subjects in Group one had significantly bigger arm girths than subjects in Group two. This difference could be due to the fact that the dancers in Group one trained significantly more hours per week compared to the dancers in Group two.

Similar results were found between the three groups of dancers studied by Clarkson et al (1989) (1). The dancers trained a mean number of hours per week in “ballet class” of 12.0(±4.9)(group A), 14.2(±5.8)(group B) and 13.1(±8.9)(group C) hours

respectively. They spent a further mean number of hours per week in rehearsals of 7.5(±3.4) (group A), 10.4(±6.6)(group B) and 9.8(±7.7)(group C) for each group. The mean arm girths(flexed) for each of the groups were group A 22.9cm(±1.7), group B 23.4cm(±1.4) and group C 22.8cm(±1.5). It is clear that the dancers in group B trained more hours per week and also had bigger arm girths(flexed).
A significant difference(p=0.02) was also found in the mean chest girth measurements between the two groups in this study. Subjects in Group one had significantly(p=0.02) bigger chest girth measurements than subjects in Group two. A possible explanation for this difference between the two groups, could be that the dancers in Group one were developmentally more mature compared to the dancers in Group two.

In contrast to this study, the studies by Hergenroeder et al (1993) (7) and Castelo-Branco et al (2006) (4) showed that dancers had smaller chest girth measurements. The dancers in the study by Hergenroeder et al (1993) (7) had a mean age of 14.9(±2.1) years and participated for a mean of 15.6(±10.9) hours per week in dance training. The dancers had mean chest girth measurements of 74.5cm(±4.3). In the study by Castelo-Branco et al (2006) (4) dancers had a mean age of 14.8(±1.7) years and trained for a mean number of 15.5 hours per week. The dancers in this group had mean chest girth measurements of 80cm.

Although the dancers in these two studies were similar in mean age and mean number of training hours per week, there was still a substantial difference in the mean chest girth measurements between the two studies. A possible explanation for this difference could be as previously stated that the dancers in the Hergenroeder et al (1993) (7) study was pre-selected from a group of dancers that were selected nationwide to join a summer dancing programme at the Houston Ballet Academy. It could be said that these dancers already projected the smaller body type characteristics associated with classical ballet. On the other hand, the dancers in the Castelo-Branco et al (2006) (4) study were recruited from a local dance school, which was possibly not as specialized.

The same could be argued for the bigger mean chest girth measurements documented in this study. The dancers were also recruited from two local ballet schools and took ballet as a subject at the school only. These dancers also participated in various other sporting activities. It is thus clear, that the dancers in this study were possibly not as specialized in ballet training as the dancers in the Hergenroeder et al (1993) (7) study. Therefore they did not have the petite characteristic body type that most of those ballet dancers had.

No significant difference was found in the mean calf(maximum) girth measurements between the two groups. It was observed that there was a small difference in the mean calf(maximum) girth measurements between the two groups, although not significantly different. The reason for this could be that Group one trained significantly($p<0.0001$) more hours per week than Group two.

In both the studies by Clarkson et al (1989) (1) and Hergenroeder et al (1993) (7), the dancers had smaller mean calf(maximum) girth measurements compared to this study. The three groups of dancers in the study by Clarkson et al (1989) (1) had the following mean calf (maximum) girth measurements: group A 33.1cm(±2.2), group B 33.5cm(±1.6) and group C 33.8cm(±1.8). The dancers in the study by Hergenroeder et al (1993) (7) had mean calf(maximum) girth measurements of 32.0cm(±2.2). The difference in the mean calf(maximum) girth measurements noted between the studies by Clarkson et al (1989) (1) and Hergenroeder et al (1993) (7), could be attributed to the mean number of hours that each group trained per week. The dancers(in the study by Clarkson et al, 1989) trained a mean number of hours per week in "ballet class" of 12.0(±4.9)(group A), 14.2(±5.8)(group B) and 13.1(±8.9)(group C) hours respectively. They spent a further mean number of hours per week in rehearsals of 7.5(±3.4)(group A), 10.4(±6.6)(group B) and 9.8(±7.7)(group C) for each group. In contrast, the dancers in the study by Hergenroeder et al (1993) (7) only danced a mean of 15.6(±10.9) hours on a weekly basis.

Table 4.3 illustrate the mean bone breadth measurements of the two groups. There was a significant difference($p=0.05$) in the mean biacromial breadth measurements between the two groups. Subjects in Group one had significantly bigger biacromial breadth measurements than subjects in Group two. It could be said that subjects in Group one had bigger biacromial breadth measurements than subjects in Group two because they were taller (although not significantly) and thus bigger.

In contrast to this study, the study by Clarkson et al (1989) (1) showed that dancers had smaller mean biacromial bone breadth measurements. The three groups of dancers had the following mean biacromial bone breadth measurements: group A

32.0cm(±2.1), group B 33.5cm(±1.8) and group C 34cm(±2.7). The dancers trained a mean number of hours per week in “ballet class” of 12.0(±4.9)(group A), 14.2(±5.8)(group B) and 13.1(±8.9)(group C) hours respectively. They spent a further mean number of hours per week in rehearsals of 7.5(±3.4)(group A), 10.4(±6.6)(group B) and 9.8(±7.7)(group C) for each group. It was clear that these dancers trained a substantial number of hours more per week compared to the dancers in this study. It could be argued that the dancers in the study by Clarkson et al (1989) (1) had smaller mean biacromial bone breadth measurements, because they were skeletally not as mature compared to the dancers in this study. Research has shown that an excessive amount of exercise, over many years, specifically during adolescence could cause a delay in skeletal growth and maturation(40).

No significant difference was found in the mean humerus bone breadth measurements between the two groups. Although there was no significant difference between the two groups, the dancers in Group one still had a bigger mean humerus breadth measurement than subjects in Group two. This is probably due to the fact that the dancers in Group one were taller (although not significantly) and thus bigger.

The results in this study compare favourably with the results obtained by Clarkson et al (1989) (1).The three groups of dancers had the following mean humerus bone breadth measurements: group A 6.1cm(±3.4), group B 5.7cm(±0.5) and group C 5.8cm(±0.3). The mean height of the three groups of dancers were: group A 160.6cm(±5.7), group B 163.5cm(±4.5) and group C 165.7cm(±7.1). The mean age of the three groups of dancers were: group A 15.1(±1.4), group B 16.0(±1.7) and group

C 17.2(±1.4). It could be said that the results were similar between the two studies because the two samples were similar in age and height.

No significant difference was found in the mean femur bone breadth measurements between the two groups. Although there was no significant difference between the two groups, the dancers in Group one still had a bigger mean femur breadth measurement than subjects in Group two. This is probably due to the fact that the dancers in Group one were taller (although not significantly) and thus bigger.

Compared to the study by Clarkson et al (1989) (1), the dancers in this study had bigger femur bone breadth measurements. In the study by Clarkson et al (1989) (1), the three groups of dancers had the following mean femur bone breadth measurements: group A 7.8cm(±0.5), group B 7.9cm(±0.3) and group C 7.9cm(±0.4). As stated before, it was clear that these dancers trained a substantial number of hours more per week compared to the dancers in this study.

Again it could be concluded that the dancers in the study by Clarkson et al (1989) (1) had smaller mean femur bone breadth measurements, because they were skeletally not as matured compared to the dancers in this study. Research has shown that an excessive amount of exercise, over many years, specifically during adolescence could cause a delay in skeletal growth and maturation(40).

Table 4.4 illustrates the somatotypes as a percentage of the total number of subjects in each of the two groups. Due to the wide spectrum of somatotypes identified amongst the two groups, neither of the two groups could be classified as a specific somatotype. Somatotype is specific to each individual's present shape and body composition (13) and therefore difficult to compare between groups as a whole. Thus the results were expressed as a percentage of the total number of subjects in each of the two groups.

The majority of the dancers in this study, in Group one, could be classified as an endo-mesomorph(n=12, 34.29%).This classification was similar to the classification in the study by Evans et al in 1985. The study compared the somatotypes of 15 dance majors with a mean age of 23.2 years to female gymnasts in other selected studies. The dancers participated in dance training for 13.2 hours per week. The somatotype of the group was anthropometrically determined according to the Heath-Carter method. The mean somatotype of the dancers were 3.43-3.07-2.97 and therefore classified as an endo-mesomorph. The somatotype of the dancers were compared to a group of gymnasts with a somatotype of 2.61-4.39-2.61.

The dancers had a lower muscularity component, but a similar ectomorphic component when compared to the group of gymnasts. The mesomorphic component of the dancers were lower due to the fact that gymnasts have more muscular development of the upperbody. Gymnasts need good upperbody strength to perform bar routines, whereas dancers hardly need upperbody strength to perform the majority of their dance routines. As a result dancers often ignore the development of the upperbody.

Evans et al (1985) (22) concluded that the dancers in their study had a balanced somatotype. In contrast to an ectomorph, the high endomorphic component often seen amongst ballet dancers could be as a result of an increased body fat percentage. A similarity between the endomorphic and mesomorphic components can often be seen, due to the well defined muscularity in the lower extremities of the dancer. The ectomorphic component would give dancers a more linear appearance. If all the three components are well balanced, the dancer will appear linear, with a small frame as well as with well defined features. A good balance between fatness, muscularity and linearity is of utmost importance to contribute to the aesthetic appearance of ballet dancers (22).

In contrast to this study, the study by Cleassens et al (1987) classified dancers as predominantly in the endo-ectomorphic and meso-ectomorphic areas of the somatochart. All dancers participated in dance training for at least 13 hours per week and their mean age was 12.7 years. The somatotype of the group was anthropometrically determined according to the Heath-Carter method. In this study, in Group two, only 15.79%(n=3) were endo-ectomorphic and 5.26%(n=1) were meso-ectomorphic.

Table 4.5 illustrates the mean age at onset of menarche in the two groups. No significant difference was found between the two groups. The fact that there was no significant difference between the two groups, could be attributed to the similarities in age, body weight and body fat percentage between the two groups. Although there was a significant difference between the total number of hours that each group trained per week, it does not seem to affect the age at onset of menarche in this group of dancers.

In contrast to this study, the study by Castelo-Branco et al (2006) (4) showed that dancers had a mean age at menarche of 12.4 years. The dancers had a mean age of 14.8 years and participated in dance training for 15.5 hours per week. This group of 38 adolescent girls were compared to a control group consisting of 77 sedentary girls, also with a mean age of 14.8 years. The mean age at menarche for the control group was 12 years. Although the dancers in the study by Castelo-Branco et al (2006) (4) trained a similar total number of hours per week as the dancers in this study, they reached menarche earlier than the dancers in this study. A possible reason for this difference, could be a difference in the body weight between the dancers in the two studies. Unfortunately such a comparison could not be made, as the body weight of the dancers were only presented as a percentage of the total group in terms of underweight, overweight or normal weight, and not as a mean of the group.

Furthermore, the girls in the study by Castelo-Branco et al (2006) (4) who started training at least 1 year before menarche, had an average age at menarche of 12.6 years and those who started training after menarche had an average age at menarche of 12.1 years. It was concluded that the age of menarche was delayed by an average of 4 months in the dancers. It could thus be said that intense physical exercise before menarche delays menarche.

The dancers in this study did not have a delay in the onset of menarche, with the exception of two dancers. These two dancers, which indicated that they have not reached menarche by the time the study was conducted, were 14 and 16 years respectively. The dancer aged 14 could be considered to have a delay in menarche and the dancer aged 16, could have possible primary amenorrhea (4).

The other dancers in this study did not have a delay in the onset of menarche. This conclusion could be made in terms of their age, body weight and body fat percentage. According to Castelo-Branco et al (2006) (4), menarche is considered delayed if the first menstrual period appeared after 14 years. The mean weight at menarche, of United States and European populations, has been shown to be approximately 46 – 47 kg. Furthermore, a body fat percentage of 22% also correlates with the onset of menarche (30).

In contrast to this study, the dancers in the study by Quintas et al (2003) (26) reached menarche only at 13.3 years. These 33 dancers with a mean age of 16.2 years, spent an average of 25.2 hours per week in dance training. Similar results were found by Bonbright (1989) (32) who investigated 32 ballet dancers with a mean age of 16.4 years. The dancers had been practicing dance for an average of 20 hours per week. The mean age for menarche was 13.5 years. It could be said that the dancers in these two studies reached menarche later than the dancers in this study, as they trained a substantial number of hours more per week (18).

Table 4.6 illustrates the menstrual cycle regularities and irregularities as a percentage of the total number of subjects in each group. Fifty percent of the subjects in group one had regular menstrual cycles and fifty percent did not. In group two 56% of the subjects had regular menstrual cycles and 44% had irregular menstrual cycles. It is clear that there was no real difference in terms of menstrual cycle regularities and irregularities between the two groups. This could be due to the fact that there was no significant difference between the two groups with regards to their body fat percentage. A body fat percentage of 22% has been shown to correlate with regular menstrual cycles (30). Although there was a significant difference in the total number of hours that each group trained on a weekly basis, this does not seem to affect the regularity of the menstrual cycles of the two groups.

This study could be compared with the studies by Castelo-Branco et al (2006) (4) and Bonbright (1989) (32) based on the similarities between the samples that were tested. In the study by Castelo-Branco et al (2006) (4), 58% (n = 21) of the dancers had regular menstrual cycles, 35% (n = 13) presented with oligomenorrhea and 8% (n = 2) had amenorrhea. On the other hand, 75% of the control group had regular menstrual cycles (n = 57), 14% (n = 11) had oligomenorrhea and the remaining 11% (n = 8) had other cycle anomalies. In the study by Bonbright (1989) (32), fourteen dancers (44%) had regular menstrual cycles, while the remaining 18 (56%) experienced menstrual dysfunction.

In this study bodymass, BMI and triceps skinfold correlated highly with a number of variables. In Group one significant correlations were found between bodymass and chest girth(0.87), arm girth(0.80) as well as BMI(0.82). Other significant correlations were also found, however at lower correlations (see table 4.7).

High significant correlations were also determined between Group one and BMI. In this relationship the highest significant correlations were between BMI and arm girth(0.92) as well as chest girth(0.80). Other significant correlations were also found, however at lower correlations (see table 4.8).

Lastly, in Group one, a number of significant correlations also existed with triceps skinfold. The highest significant correlation was with body fat percentage(0.94). The other significant correlations were at much lower levels (see table 4.9).

Furthermore, significant correlations were also found in Group two and a number of variables. In Group two, the highest significant correlations were with bodymass and triceps skinfold. Bodymass correlated highly with chest girth(0.94) as well as calf girth(0.92). A significant correlation was also determined with arm girth(0.83), however at a much lower level(see table 4.10).

Triceps skinfold correlated highly with body fat percentage(0.95) in Group two. It also correlated with medial calf skinfold(0.78) and arm girth(0.74), although at a much lower level(see table 4.11).

Based on the correlations found in this study, a shortened test battery could be recommended pertaining to the anthropometric measurement of female adolescent ballet dancers. The recommended shortened test battery could be the measurement of bodymass, as it correlated significantly with BMI(0.82), triceps skinfold(0.69), subscapular skinfold(0.58), medial calf skinfold(0.57), supraspinale skinfold(0.62), body fat percentage(0.67), arm girth(0.80) as well as chest girth(0.87) in Group one. In Group two bodymass correlated significantly again with arm girth(0.83) and chest(0.94), but also with calf girth(0.92).

The measurement of BMI could also form part of the test battery as it correlated significantly with triceps skinfold(0.76), subscapular skinfold(0.68), supraspinale skinfold(0.59), medial calf skinfold(0.62), body fat percentage(0.73), arm girth(0.92), chest girth(0.80), calf girth(0.78) as well as femur breadth(0.60) in Group one.

Lastly, the test battery could also include the measurement of triceps skinfold as it correlated significantly with subscapular skinfold(0.75), supraspinale skinfold(0.79), medial calf skinfold(0.77), body fat percentage(0.94), arm girth(0.72) as well as chest girth(0.64) in Group one. In Group two triceps skinfold correlated significantly again with medial calf skinfold(0.78), body fat percentage(0.95) and arm girth(0.74).

Thus, it is clear from the correlations mentioned above, that the measurement of bodymass, BMI and triceps skinfold represents a number of anthropometric measurements. Therefore it could be concluded that these three measurements could give adequate information with respect to the body composition of female adolescent ballet dancers. As a result, one could omit the measurement of the other listed variables form a test battery. However, it is recommended that these results be verified in a larger group of ballet dancers.

No previous studies did correlations with their data in order to indicate relationships between the different anthropometric measurements and training hours. Hence, there were no comparative data for this study.

As evident from the literature, the measurement of bodymass, BMI and percent body fat are routine body composition measurements important to ballet dancers. Table 4.12 illustrates the correlations between Group one and these variables as well as the total hours of physical activity on a weekly basis. The same correlations were determined for Group two, as listed in Table 4.13.

Surprisingly, no significant correlations existed between bodymass, BMI, percent body fat and the total hours of physical activity on a weekly basis in each of the two groups. It could be concluded, that physical activity does not play such an important role with regards to the outcome of these variables. It could also be that these variables are more dependent on dietary intake as oppose to physical activity.

No previous studies did correlations with their data in order to indicate relationships between bodymass, BMI, percent body fat and training hours. Hence, there were no comparative data for this study.

CHAPTER 6

6.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMARY

A brief summary of the main findings will be discussed in this chapter. The main conclusions derived from the research will be presented. Recommendations for health care professionals involved in dancer health and wellness will be made. The importance of body composition assessment for coaches will be discussed. The importance of further research pertaining to female adolescent ballet dancers will be emphasized.

The study showed that a null hypothesis is true, because there was no significant difference between the body composition of the group which trained less or equal to ten hours per week and the group which trained more than ten hours per week.

A highly significant difference was found in the total number of hours that the two groups trained on a weekly basis. A significant difference was also found in the total number of hours spent on ballet training, on a weekly basis, between the two groups. The other significant findings between the two groups were body mass, mean arm girth(flexed), mean chest girth and mean biacromial breadth measurements.

The results documented for age, stature, body mass index and percentage body fat were not significantly different between the two groups. The results obtained for calf girth, humerus and femur breadth were also not significantly different between the two groups. The group that trained more had higher measures for all components tested. The somatotypes in each group were expressed as a percentage of the total number of subjects in that group. The somatotypes of the subjects in Group one were predominantly localized in the endo-mesomorphic and endo-ectomorphic areas. Subjects in Group two were predominantly classified as ecto-endomorph.

No significant difference was found between the two groups with regards to the mean age at onset of menarche.

A higher percentage of dancers in Group two had regular menstrual cycles compared to the dancers in Group one.

In Group one, the highest correlations were found between bodymass and chest girth, arm girth as well as BMI. The highest correlations determined in this group with regards to BMI was with arm girth as well as chest girth. Furthermore, the highest correlation was also found between triceps skinfold and body fat percentage in Group one.

In Group two, the highest correlations were found between bodymass and chest girth as well as calf girth. The highest correlations determined in this group with regards to triceps skinfold was with body fat percentage.

No significant correlations were found between bodymass, BMI, body fat percentage and the total hours of physical activity per week for the dancers in the two groups.

The duration of training of each group of dancers, have only been presented as the total number of training hours per week. This was done as the data obtained from the questionnaires, with regards to the training habits of the dancers, were not precise enough to be used. Therefore it was difficult to determine exactly which proportion of the hours spent in training was devoted to a specific dance form or sporting activity, with the exception of ballet training, which was used in this study.

The data obtained from the questionnaire with regards to the total number of hours spent per week on ballet training, was not answered clearly by all subjects. For this reason, the answers from three subjects had to be omitted from this section. Therefore the total number of subjects, used to calculate this specific result, in each group was: 33 in Group one and 18 in Group two.

6.2 Conclusions

The study showed that the difference between training hours (≤ 10 hours vs > 10 hours per week) show no significant differences with respect to a number of anthropometric measurements.

The correlation results with respect to anthropometric data indicated that bodymass, BMI and triceps skinfold measurements are the best measures to represent anthropometric data in female adolescent ballet dancers.

The correlation results also indicated that bodymass, BMI and percent body fat are not dependent on physical activity, but these variables might be more influenced by other factors, such as dietary intake.

6.3 Recommendations

Body composition assessment should become routine practice for health care professionals involved in ballet dancer health and wellness. It could serve as a tool to quantify appearance in dance in order to guide adolescent dancers towards appropriate body composition goals. The data obtained from body composition can be used to identify the “at risk dancer” and thus serve as a screening tool. Young dancers at risk to develop amenorrhea and possible osteoporoses later in life can be identified. Health care professionals would have the opportunity to educate adolescent dancers with regard to optimal training regimes and nutritional advice, not only pertaining to health but also to optimal performance.

The routine assessment of body composition by health care professionals could also be of great value for coaches with regards to:

- Having normative data for a specific group of dancers.
- Having individual baseline data in order to set educational and training or rehabilitative goals.

- Classifying dancers based on research data to determine participation in a specific form of dance.
- Developing characteristics for a given level of performance (42).

The review of relevant literature revealed the tremendous gap in the literature with regards to female adolescent ballet dancers. Most studies that have been done concentrated on adult female professional ballet dancers. The importance of encouraging more research in this field, is not only to contribute to the existing anthropometric data available on female adolescent ballet dancers in general, but specifically in South Africa.

CHAPTER 7

7.0 REFERENCES

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8.0 APPENDICES

8.1 Approval of title letter

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Faculty of Health Sciences
Medical School, 7 York Road, Parktown, 2193
Fax: (011) 717-2119
Tel: (011) 717-2745

Reference: Ms Tania Van Leeve
E-mail: tania.vanleeve@wits.ac.za
13 October 2009
Person No: 333613
PAG

Ms T Lourens
PO Box 10293
Vorna Valley
1686
South Africa

Dear Ms Lourens

Master of Science in Medicine (Biokinetics): Approval of Title

We have pleasure in advising that your proposal entitled "*Anthropometric measurements of female adolescent ballet dancers*" has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

8.2 Letter of approval by the Human Research Ethics Committee of the University of the Witwatersrand

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ms Tanya Lourens

CLEARANCE CERTIFICATE	**M091001**
PROJECT	Anthropometric Measurements of Female Adolescent Ballet Dancers in Gauteng, South Africa
INVESTIGATORS	Ms Tanya Lourens.
DEPARTMENT	Centre for Exercise Science and Sports Medicine
DATE CONSIDERED	2009/10/30
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 2009/11/24 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : Prof Y Coopoo

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

....

8.3 Permission letter from the Gauteng Department of Education

UMnyango WezeMfundo
Department of Education

Lefapha la Thuto
Departement van Onderwys

Enquiries: Nomvula Ubisi (011)3550488

Date:	**24 November 2009**
Name of Researcher:	**Lourens Tanya**
Address of Researcher:	**21 Brendon Avenue**
	Morningside Manor
	Sandton 2052
Telephone Number:	**0118021957/0829680804**
Fax Number:	**0118022498**
Research Topic:	**Anthropometric Measurements of Female Adolescent Ballet Dancers**
Number and type of schools:	**2 Secondary Schools**
District/s/HO	**Gauteng East and Johannesburg North**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

Office of the Chief Director: Information and Knowledge Management
Room 501, 111 Commissioner Street, Johannesburg, 2000 P.O.Box 7710, Johannesburg, 2000
Tel: (011) 355-0809 Fax: (011) 355-0734

4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

Pp Nomvula Ubisi
Martha Mashego
ACTING DIRECTOR: KNOWLEDGE MANAGEMENT & RESEARCH

The contents of this letter has been read and understood by the researcher.	
Signature of Researcher:	[signature]
Date:	26/11/2009

8.4 Permission letter from Mr. Norambuena from the National School of the Arts, Johannesburg.

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

INFORMATION SHEET

Date: 1/09/2009

Dear Mr. Norambuena

I am currently doing my Masters in Biokinetics through WITS University. My supervisor for the study is Prof Y Coopoo. I am researching the differences in body size and measurements and body type between two groups of female adolescent ballet dancers training more than 10 hours per week and those training less aged 13 – 18 years.

These findings can serve as guidelines in an effort to quantify appearance in dance in order to guide young dancers towards appropriate training goals. The data can be used to identify the "at risk dancer" and thus serve as a screening tool. Young dancers at risk to develop amenorrhea (menstrual cycle abnormalities due to over training and malnutrition) and possible osteoporoses later in life can be identified. Finally, results can be used to educate young adolescent dancers and their coaches with regard to maintaining a healthy body composition and the changes that might result from intensive physical conditioning.

The study is a complete blind study. This means that each dancer will only be identified by a number. The assessment forms and data recording forms will only have their number on, and the identity of the dancer will remain anonymous. All students and their parents will be requested to sign a parental consent and child assent form before testing will be commenced.

If parents and teachers wish to see the results, an interview will be scheduled with the researcher. All results will remain completely confidential and no one in the medical team or any of the teachers will have access to the results, unless permission is granted by the parents and dancer. This study will not influence the student's training and there will be no cost involved for students, parents or the school.

The benefit for students participating in the study will be:

- To have their baseline data recorded with regards to their body composition and structure. These results can be compared to the standard norms for ballet dancers of their age group. An applicable exercise program can be designed to bridge any gaps between their current body composition and the standard norms.
- Follow-up data can be recorded and compared to the baseline data. As a result, a data log book and training record can be compiled in order to benefit the future development and growth of the student dancer.

I herewith request your permission, as head of the ballet department at the National School of the Arts in Johannesburg, to test the students of the ballet school. Please sign the letter at the bottom of the page if you agree to allow the students at your school to be tested

Yours faithfully

Tanya Lourens

Mr. M Norambuena

8.5 Permission letter from Mrs Naudé from the Waterkloof High School, Pretoria.

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

INFORMATION SHEET **Date: 1/09/2009**

Dear Michelle Naudé

I am currently doing my Masters in Biokinetics through WITS University. My supervisor for the study is Prof Y Coopoo. I am researching the differences in body size and measurements and body type between two groups o female adolescent ballet dancers training more than 10 hours per week and those training less aged 13 – 1? years.

These findings can serve as guidelines in an effort to quantify appearance in dance in order to guide youn dancers towards appropriate training goals. The data can be used to identify the "at risk dancer" and thus serve a a screening tool. Young dancers at risk to develop amenorrhea (menstrual cycle abnormalities due to ove training and malnutrition) and possible osteoporoses later in life can be identified. Finally, results can be used t educate young adolescent dancers and their coaches with regard to maintaining a healthy body composition an the changes that might result from intensive physical conditioning.

The study is a complete blind study. This means that each dancer will only be identified by a number. Th assessment forms and data recording forms will only have their number on, and the identity of the dancer wi remain anonymous. All students and their parents will be requested to sign a parental consent and child assen form before testing will be commenced.

If parents and teachers wish to see the results, an interview will be scheduled with the researcher. All results wi remain completely confidential and no one in the medical team or any of the teachers will have access to th results, unless permission is granted by the parents and dancer. This study will not influence the student's trainin and there will be no cost involved for students, parents or the school.

The benefit for students participating in the study will be:

- To have their baseline data recorded with regards to their body composition and structure. Thes results can be compared to the standard norms for ballet dancers of their age group. An applicab exercise program can be designed to bridge any gaps between their current body composition an the standard norms.
- Follow-up data can be recorded and compared to the baseline data. As a result, a data log boo and training record can be compiled in order to benefit the future development and growth of th student dancer.

I herewith request your permission, as head of the ballet department at the Waterkloof High School in Pretoria, t test the students of the ballet school. Please sign the letter at the bottom of the page if you agree to allow th students at your school to be tested.

Yours faithfully

Tanya Lourens

Michelle Naudé

8.6 Parental information sheet

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

INFORMATION SHEET

Dear Parents,

I am currently doing my Masters in Biokinetics through WITS University. My supervisors for the study are Prof. Yoga Coopoo and Prof. Demitri Constantinou. I am researching the differences in body size and measurements and body type between two groups of female adolescent ballet dancers training more than 10 hours per week and those training less. I invite your child to be part of the above study and I request your permission for your child to be part of the study. The testing will be done one afternoon, after the normal school day, on the school premises.

These findings can serve as guidelines in an effort to quantify appearance in dance in order to guide young dancers towards appropriate training goals. Results can be used to educate young adolescent dancers and their coaches with regard to maintaining a healthy body composition and the changes that might result from intensive physical conditioning.

The study results will be kept confidential. This means that each dancer will only be identified by a number. The assessment forms and data recording forms will only have their number on, and the identity of the dancer will remain anonymous. The results will be analyzed as a group and not by individuals.

If parents wish to see the results, an interview will be scheduled with the researcher. All results will remain completely confidential and not any of the dance teachers or coaches will have access to the results, unless permission is granted by the parents and dancer. This study will not influence your child's training and there will be no cost involved for you as parents.

There is no direct benefit to the participation in the study, although the results may be useful generally. Participants will have their baseline data recorded with regards to their body composition and structure. These results can be compared to the standard norms for ballet dancers of their age group. An applicable exercise program can be designed to bridge any gaps between their current body composition and the standard norms. Follow-up data can be recorded and compared to the baseline data. As a result, a data log book and training record can be compiled in order to benefit the future development and growth of the student dancer.

If you are comfortable with your daughter taking part in my research, please sign the attached consent form. If your daughter would like to participate in the study, please allow her to sign the attached assent form. Please note that your daughter is free to withdraw from the study at any point in time without penalty.

If you have any queries or complaints you can contact the Human Research Ethics Committee Chairman, Prof Cleaton Jones on 011 717 2301.

Yours faithfully

Tanya Lourens

8.7 Subject information sheet

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

SUBJECT INFORMATION SHEET

Hallo, my name is Tanya Lourens. I am currently doing my Masters in Biokinetics through WITS University. I am inviting you to take part in a study as I would like to investigate if there are differences in body measurements with different training durations (of female ballet dancers aged 13 – 18 years) between those dancers dancing more than 10 hours and those dancing less than 10 hours per week. The testing will be done one afternoon, after the normal school day, on the school premises.

In the study measurements are taken of your height and body weight. Body measurements such as circumferences using a tape measure as well as skinfolds using a skin caliper are done. The measurements won't hurt and will only take a few minutes to do.

You are requested to complete a questionnaire with regards to your general health, training, conditioning methods and eating patterns.

The study results will be kept confidential. This means that each dancer will only be identified by a number. The assessment forms and data recording forms will only have their number on, and the identity of the dancer will remain anonymous. The results will be analyzed as a group and not by individuals.

If parents wish to see the results, an interview will be scheduled with the researcher. All results will remain completely confidential and not any of the dance teachers or coaches will have access to the results, unless permission is granted by the parents and dancer. This study will not influence your training at all.

If you wish to be part of the testing you would also be requested to sign the consent form. I will also ask your parents if they will agree to let you participate in the testing and only if they also agree will you be part of this study. If your parents agree for you to be part of the study, they would have to sign the informed consent form.

Your testing results will be completely confidential and you are free to withdraw from the study at any time without penalty.

If you have any concerns or questions related to the study, you are free to contact me on 082 9680 804 or 011 8021957.

Dancer's name _________________________________ Date _____________

Dancer's signature ______________________________ Date _____________

Signature of tester _____________________________ Date _____________

8.8 Parental consent form

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

PARENTAL CONSENT FOR YOUR CHILD

I, Tanya Lourens, a master's student in Biokinetics at the University of the Witwatersrand, request your child's participation in a research study. The title of the research study is: **ANTHROPOMETRIC MEASUREMENTS OF FEMALE ADOLESCENT BALLET DANCERS.**

The purpose of the research is to investigate the body shape, size and structure of two groups of female adolescent ballet dancers, classified as having low – moderate training and those having moderate - high training. These findings can serve as guidelines in an effort to quantify appearance in dance in order to guide young dancers towards appropriate body composition goals. A dancer will be classified as having a specific somatotype, giving a true reflection of their physique, as opposed to simply being grouped according to body weight. The data can be used to identify the "at risk dancer" and thus serve as a screening tool. Young dancers at risk to develop amenorrhea (menstrual cycle abnormalities due to over training and malnutrition) and possible osteoporosis later in life can be identified. Finally, results can be used to educate young adolescent dancers and their coaches with regard to maintaining a healthy body composition and the changes that might result from intensive physical conditioning.

Participants will be measured on body weight and height, limb lengths and circumferences, and skinfolds. There are no risks or discomforts during these measurements. Participants are requested to complete a questionnaire with regards to their demographic information, general health, training and conditioning methods and eating patterns.

There is no direct benefit to the participation in the study, although the results may be useful generally. Participants will have their baseline data recorded with regards to their body composition and structure. These results can be compared to the standard norms for ballet dancers of their age group. An applicable exercise program can be designed to bridge any gaps between their current body composition and the standard norms. Follow-up data can be recorded and compared to the baseline data. As a result, a data log book and training record can be compiled in order to benefit the future development and growth of the student dancer.

I understand that the results of the research study may be published, but my child's name or identity will not be revealed. In order to maintain confidentiality of my child's records, each dancer will only be identified by a number. The assessment forms and data recording forms will only have their number on, and the identity of the dancer will remain anonymous. Not any of the dance teachers or coaches will have access to the results, unless permission is granted by the parents and dancer.

The research in which my child will be participating does not involve any risk and there will be no compensation for my child's participation.

I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Tanya Lourens, 21 Brendon Ave, Morningside Manor, Johannesburg, 011 802 1957/0829680804. I understand that in case of injury, if I have questions about my rights as a subject/participant in this research, or if I feel I have been placed at risk, I can contact the Human Research Ethics Committee Chairman, Prof Cleaton Jones on 011 717 2301.

I have read and understood the above information. The nature of the study has been explained to me. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving my legal claims, rights or remedies. A copy of this consent form will be given to me.

______________________________Date____________
(Father, mother, legal guardian)

I certify that I have explained to the above individual the nature and purpose, the potential benefits, and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. I have provided the subject/participant a copy of this signed consent document.

Signature of investigator _________________________Date______________

8.9 Child assent form

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

CHILD ASSENT FORM

Hallo, my name is Tanya Lourens. I am currently doing my Masters in Biokinetics through WITS University. I am inviting you to take part in a study as I would like to investigate if there are differences in body measurements with different training durations (of female ballet dancers aged 13 – 18 years) between those dancers dancing more than 10 hours and those dancing less than 10 hours per week. The testing will be done one afternoon, after the normal school day, on the school premises.

If you agree to be in this study, measurements are taken of your height and body weight. Body measurements such as circumferences using a tape measure as well as skinfolds using a skin caliper are done. The measurements won't hurt and will only take a few minutes to do. There are also no risks or discomforts during these measurements.

You are requested to complete a questionnaire with regards to your general health, training, conditioning methods and eating patterns.

The results of the tests will be kept confidential at all times and not any of the dance teachers or coaches will have access to the results, unless permission is granted by your parents and yourself.

Please talk to your mom and dad/guardian if they are happy to allow me to test you for my study and if you wish to be part of the testing. I will also ask your parents if they will agree to let you participate in the testing and only if they also agree will you be part of this study. If you wish to be part of the testing you would also be requested to sign the consent form. If your parents agree for you to be part of the study, they would have to sign the informed consent form.

If you are not certain about being tested and completing the questionnaire, you are welcome to ask me any questions you have with regards to the testing and what I am looking to measure. If you cannot think of any questions at the moment you are welcome to phone me and ask me at any time. My cell number is: 0829680804 and my home telephone number is: 011 802 1957.

If you wish to withdraw at any stage during the testing you are free to do so and I will not do anymore tests on you. You will not be penalized for withdrawing from the study.

Dancer's name ________________________________ Date _____________

Dancer's signature _____________________________ Date _____________

Signature of tester ____________________________ Date _____________

8.10 Questionnaire

University of the Witwatersrand
Centre for Exercise Science and Sports Medicine

The questionnaire has been formulated to determine the medical history, dietary habits and exercise habits of adolescent ballet dancers aged 13 – 18 years. Your involvement in this survey is voluntary and you are free to withdraw at any time. To ensure confidentiality please do not write your name on the questionnaire.

Read the questions carefully and answer by marking an "X" in the blocks provided. Where a specific answer is required, please answer on the space provided. Do not communicate with other participants when completing the questionnaire. Feel free to ask any questions.

Thank you for your participation in this study.

1. DEMOGRAPHIC INFORMATION

Participant number: ____

Age:____

2. MEDICAL HISTORY

1. When was the last time you had a physical examination?

   ____

2. Do you have any allergies to any medications, foods or any substances? If yes, please list them.

   ____

3. Are you currently taking any medication? If yes, please list medication(s).

   Yes □ No □

   ____

During the past 12 months:

1. Has a physician prescribed any form of medication for you?
   Yes □ No □

2. Has your weight fluctuated more than a few kilograms?
   Yes □ No □

   If yes, please indicate:

Weight increased with:	Weight decreased with:
< 1kg □	< 1kg □
1-2kg □	1-2kg □
3-4kg □	3-4kg □
4-5kg □	4-5kg □
>5kg □	

3. Have you experienced any faintness, light-headedness, or blackouts?
   Yes □ No □

4. Have you at any stage experienced trouble sleeping?
   Yes □ No □

5. Have you experienced any blurred vision?
   Yes □ No □

6. Have you had any severe headaches?
   Yes □ No □

7. Do you have? :

Asthma □ Diabetes □ Lower back pain □

Swollen joints □ Exercise induced asthma □

8. How often do you suffer from flu in a year?
____

9. Age of menarche (age of onset of menstrual cycle):_________________

10. Average duration of menstrual cycle per month (days):_____________

11. Do you have regular monthly menstrual cycles (days between cycles are the same each month):
Yes □ No □

3. DIETARY HABITS

1. What is your current weight?___________Kg Height:_____________cm

2. What would you like to weigh?____________Kg

3. What is the most you have ever weighed?________Kg

4. Have you tried any weight-loss methods? If yes, which?__________________________________
____

5. How often do you miss?

- Breakfast: □ Never □ Everyday □ Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

- Midmorning snack: □ Never □ Everyday □ Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

- Lunch: □ Never □Everyday □ Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

- Midafternoon snack: □ Never □ Everyday □Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

- Dinner: □ Never □ Everyday □ Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

- After-dinner snack: □ Never □ Everyday □ Once a week □ 2-3 days per week □ 3-4 days per week □ 4-5 days per week □ 5-6 days per week

6. How often do you eat out each week?______ Times

7. What size portions do you normally have?
□ Small □ Moderate □ Large □ Uncertain

8. How often do you eat more than one serving?

- Breakfast: □ Always □ Usually □ Sometimes □ Never
- Lunch: □ Always □ Usually □ Sometimes □ Never
- Dinner: □ Always □ Usually □ Sometimes □ Never

9. How long does it usually take you to eat a meal?________ Minutes

10. Do you eat while doing other activities (e.g., watching TV, reading and working)? If yes, please indicate.
Yes □ No □
Activity: _______________

11. When you snack, how many times a week do you eat the following?

Biscuits, cake, pie_______ Sweets__________ Cooldrinks________

Doughnuts_____________ Fruit_______

Milk or milk beverages _________ Potato chips, pretzels, etc.____________

Peanuts or other nuts __________ Ice Cream _____________

Cheese and crackers __________ other _________________

12. How often do you eat dessert?

Times a day ____________
Times a week____________

13. What dessert do you eat most often?__________________________________

14. How often do you eat fried foods?________Times per week

15. Do you salt your food at the table?

□ Yes □ No

□ Tasting it □ After tasting it

16. Do you use any dietary supplements?
□ Yes □ No
If yes, which? ____

4. EXERCISE HABITS

1. Do you exercise vigorously on a regular basis? □ Yes □ No

2. What activities do you engage in on a regular basis? __________________

3. If you walk, run or jog, what is the average number of km you cover each workout?________Km

4. How many minutes on the average is each of your exercise workouts? ________minutes

5. How many workouts a week do you participate in on average? _____workouts

6. Hours per week involved in other extracurricular sports, other than ballet ____

7. At what age did you start with ballet training? _________________________

8. Number of hours per week in dance training by dance type:

a. Ballet __________ b. Modern_________ c. Jazz _______________

d. Contemporary_________ e. Other __________

9. For how many years have you been doing ballet training at least twice a week? ________

10. What activities do you do on a regular basis besides ballet training?

______ Walking, running or jogging
______ Stationary running
______ Skipping
______Bicycling
______ Stationary cycling
______Step aerobics
______Handball, racquetball, or squash
______ Basketball
______ Swimming
______Tennis
______ Aerobic dance
______ Stair-climbing
______ Other (specify)

How long do you participate in the above mentioned activities (if any)?

Duration per session ___________ minutes

Frequency (how often) □ 1 x week
□ 2 x week
□ 3 x week
□ 4 x week
□ 5 or more x week