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DOES A RELATIONSHIP EXIST BETWEEN PHYSICAL FITNESS AND ACADEMIC PERFORMANCE IN UNIVERSITY STUDENTS?



University of Pretoria

by

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DEDICATION

This dissertation is dedicated to:

- *My Heavenly Father, for without him none of this would have been possible. “**Life is good because God is great**” ~ Unknown*
- *Professor P.E. Krüger, for constantly encouraging me to further my studies. “**Great leaders inspire greatness in others**” ~ Unknown*
- *My beautiful family (André, Susan, and Tracey Steenkamp, Michelle and Monique Smith, and Jeandré, Joshua and Matthew Hunter) for their love, support, friendship, and encouragement throughout my life. “**Family is a gift that lasts forever**” ~ Unknown*

“Education is the most powerful weapon which you can use to change the world.” Nelson Mandela



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ABSTRACT

TITLE: DOES A RELATIONSHIP EXIST BETWEEN PHYSICAL FITNESS AND ACADEMIC PERFORMANCE IN UNIVERSITY STUDENTS?

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South Africa's universities have one of the lowest graduation rates around the world, putting South Africa's education in a state of crisis. For this reason it is important to find ways on improving the academic performance of students as their marks will depend on whether they can secure a job position in the future. Physical inactivity among university students is also a major concern as it causes health problems. Poor health causes the student to miss class which may negatively impact their academic performance. Thus, the study aimed to establish whether an association existed between the components of physical fitness and academic performance in university students, and whether health had an effect on student's academic performance.

A descriptive correlational study design was used. The sample consisted of 99 first year students. Each participant completed an informed consent, indemnity and a Par-Q form before participating in the study. A health screening questionnaire was completed and physical fitness testing (the Harvard step test, hand-grip dynamometer strength test, Heath and Carter somatotype method, minute sit-up test and sit-and-reach test) took place in January, May, and in October. The academic result average was used to measure academic performance.

There was a strong positive relationship ($p < 0,001$; $r = 0,55$) when comparing academic performance to Admission Point (AP) score; a fair negative relationship ($p = 0,02$; $r = -0,25$) when comparing academic performance to height; a fair negative relationship ($p = < 0,001$; $r = -0,38$) when comparing academic performance

to weight; a fair negative relationship ($p = 0,02$; $r = -0,25$) when comparing academic performance to waist circumference; a fair negative relationship ($p = 0,002$; $r = -0,33$) when comparing academic performance to hip circumference; a fair negative relationship ($p = 0,03$; $r = -0,23$) when comparing academic performance to muscle strength; a fair negative relationship ($p = 0,002$; $r = -0,33$) when comparing academic performance to BMI; and a fair positive relationship ($p = 0,007$; $r = 0,28$) when comparing academic performance to health status. A statistically significant difference was found in Test 3 when comparing academic performance to cardiovascular endurance ($p = 0,02$). When comparing the categories of cardiovascular endurance to academic performance, there were statistically significant differences between the poor and low category ($p = 0,04$), poor and good category ($p = 0,007$), excellent and good category ($p = 0,02$) and high to good category ($p = 0,01$).

Individual components of physical fitness do not appear to have a strong effect on academic performance or on health status, rather the overall improvement in health status as a result of being physically fit, is the determining factor. This coincides with Tremblay *et al.* (2000) who stated that physical activity may be indirectly related to enhanced academic performance by improving physical health and self-esteem.

In conclusion, it is recommended that universities incorporate comprehensive health promotion programmes into the university setting as they have the potential to add to population health and positively influence educational achievement in university students.

Keywords: physical fitness; components of physical fitness; physical activity; academic performance; cognitive functioning; health status; AP score; university students



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LIST OF ABBREVIATIONS

%	per cent (one part in every hundred)
°	degree (symbol)
>	greater than (symbol)
<	less than (symbol)
≥	greater than, or equal to (symbol)
≤	less than, or equal to (symbol)
=	equal to (symbol)
x	multiply (symbol)
ACSM	American College of Sports Medicine
AP score	admission point score
BA (HMS)	Baccalaureus Artium (Human Movement Science)
B (SportSci)	Bachelor of Sport Science
BDNF	brain-derived neurotrophic factor
BMI	body mass index (relative size based on height and mass)
cm	centimetre(s) (linear measurement of distance)
IQ	intelligence quotient (measure of assessment of human intelligence)
kg	kilogram(s) (unit of mass)
kg.m⁻²	kilogram(s) per metre(s) squared

mm	millimetre(s) (unit of mass)
n	number of participants in a group
NHC	National Higher Certificate
Par-Q	physical activity readiness questionnaires (self-screening tool)
PFC	prefrontal cortex
SES	socio-economic status
SD	standard deviation (quantifies the amount of dispersion of a set of data values)
VO₂	oxygen uptake (volume of oxygen)
VO₂ max	maximal oxygen uptake (maximum volume of oxygen)
YMCA	Young Men's Christian Association
WHO	World Health Organization (specialised agency of the United Nations)

CHAPTER 1: INTRODUCTION

1.1. Introduction

Physical inactivity among university students is a major concern as it causes serious health problems (Spence & Lee, 2003; Irwin, 2007). Unfortunately in today's society, more and more university students are adopting sedentary lifestyles (Keating *et al.*, 2005). Poor health causes students to miss lectures (Jensen, 1998; Keeley & Fox, 2009; Woodward, 2009; Mujović & Čubrilo, 2012), which may impact their academic performance negatively (Tsouros *et al.*, 1998; Chomitz *et al.*, 2009). Approximately half of young people aged 12–21 are not vigorously active on a habitual basis (US Department of Health and Human Services, 2000). Interventions are therefore needed to persuade students to become active so as to gain health benefits and prevent illness and disease (Fox, 1999; Strong *et al.*, 2005). A healthy population requires less medical care and is more productive, which means that it contributes more to the economy (Adler *et al.*, 2007). A “health promoting university” will add value to society by promoting and protecting the health of staff, students and the wider community. Healthier students are better learners, which means that at a health promoting university, academic performance will improve and fewer students will abandon their studies (Tsouros *et al.*, 1998). This is important as academic performance is directly related to a country's social and economic development (Mushtaq & Khan, 2012).

Various associations between the mind and body have been cited, and have resulted in the belief that physical activity could assist learning (Shephard, 1997; Jensen, 1998; Van Praag *et al.*, 1999; Dwyer *et al.*, 2001; Chomitz *et al.*, 2009). Regular physical activity has been shown to have positive effects on brain health (Colcombe *et al.*, 2003; Dishman *et al.*, 2006; Chomitz *et al.*, 2009; Al-Nader *et al.*, 2013) and to result in a higher capillary volume (Kramer *et al.*, 2002; Studenski *et al.*, 2006), as well as a greater density of neuronal synapses (Black *et al.*, 1987; Trudeau & Shephard, 2008; Chomitz *et al.*, 2009). Physical activity improves cardiovascular fitness (Thirlaway & Benton, 1992; Etnier *et al.*, 2006; Huang *et al.*, 2013; Plowman

& Smith, 2014), which increases blood flow to the cortex of the brain (Herholz *et al.*, 1987; Shephard, 1997; Cotman & Berchtold, 2002; Barnes *et al.*, 2003; Taras, 2005; Lambourne, 2006; Hall, 2007; Pereira *et al.*, 2007; Hillman *et al.*, 2008; Trudeau & Shephard, 2008; Du Toit *et al.*, 2011). This in turn leads to an increase in the nutrients used by the brain (Hall, 2007) and helps with cognitive reasoning and functioning (Woodward, 2009). Physical activity also stimulates the prefrontal cortex (PFC) which is used in problem solving and learning (Jensen, 1998). It increases the levels of brain-derived neurotrophic factor (BDNF) (Cotman & Berchtold, 2002; Winter *et al.*, 2007; Lou *et al.*, 2008; Huang *et al.*, 2013) and serotonin (Cotman & Berchtold, 2002; Winter *et al.*, 2007), which enables the brain to be more adaptive to change (Cotman & Berchtold, 2002; Colcombe *et al.*, 2003). Physical education is an essential aspect of students' academic success (Grissom, 2005) since it has been shown to improve cognition (US Department of Health and Human Services, 1996; Etnier *et al.*, 1997; Fox, 1999; Laurin *et al.*, 2001; Churchill *et al.*, 2002; Barnes *et al.*, 2003; Colcombe & Kramer, 2003; Dik *et al.*, 2003; Hillman *et al.*, 2005; Dishman *et al.*, 2006; Etnier *et al.*, 2006; Kramer *et al.*, 2006; Vaynman & Gomez-Pinilla, 2006; Burton & Van Heest, 2007; Castelli *et al.*, 2007; MacAuley, 2007; Winter *et al.*, 2007; Hillman *et al.*, 2008; Tomporowski *et al.*, 2008; Van Praag, 2008; Chomitz *et al.*, 2009; Du Toit *et al.*, 2011; Davenport *et al.*, 2012; Al-Nader *et al.*, 2013; Aye *et al.*, 2013; Huang *et al.*, 2013). Higher levels of physical fitness are associated with improvements in recreation and work (Fox, 1999; Eveland-Sayers *et al.*, 2009), and enhance one's ability to perform daily tasks (US Department of Health and Human Services, 1996). It is thought that students who are successful in one area, such as physical activity, also strive for success in other areas, including academic performance (Shephard *et al.*, 2011).

Numerous benefits are associated with being physically active (US Department of Health and Human Services, 1996; Fox, 1999; Dishman *et al.*, 2006; Warburton *et al.*, 2006; Hillman *et al.*, 2008; Eveland-Sayers *et al.*, 2009; Du Toit *et al.*, 2011; Mujović & Čubrilo, 2012; Plowman & Smith, 2014). Physical activity leads to an improvement of psychological variables, including depression, anxiety, tension, stress (Folkens *et al.*, 1972; Lichtman & Poser, 1983; Shephard, 1983; US Department of Health and Human Services, 1996; Fox, 1999; Dishman *et al.*, 2006; Eveland-Sayers *et al.*, 2009; Al-Nader *et al.*, 2013) and mood states (Lichtman &

Poser, 1983; Thirlaway & Benton, 1992; US Department of Health and Human Services, 1996; Fox, 1999; Taras, 2005; Nelson & Gordon-Larsen, 2006; Adler *et al.*, 2007; Van Praag, 2008; Keeley & Fox, 2009; Al-Nader *et al.*, 2013). It also improves one's attention in the classroom (Shephard, 1997; Coe *et al.*, 2006; Trost, 2007; Chomitz *et al.*, 2009). Physical activity is a cheap method that can be used to improve self-perception, social interaction and overall quality of life (US Department of Health and Human Services, 1996; Fox, 1999).

Leading an active lifestyle contributes to improvements in cardiovascular (Tremblay *et al.*, 2000; ACSM, 2010; Townsend *et al.*, 2012) and respiratory function. It leads to a reduction in coronary artery disease risk factors (blood pressure, cholesterol, diabetes, blood platelet adhesiveness) and decreases morbidity and mortality (MacAuley, 2007; ACSM, 2010; Bloemhoff, 2010). Endurance training decreases platelet adhesiveness and enhances the breakdown of blood clots thereby reducing the risk of thrombosis (US Department of Health and Human Services, 1996).

Physical inactivity often begins early in life (Rodenroth, 2010). It is extremely unhealthy (Booth *et al.*, 2000) and an expensive public health burden (Powell & Blair, 1994). Physical inactivity is the primary cause of coronary heart disease (US Department of Health and Human Services, 1996; Booth *et al.*, 2000), doubling the risk of morbidity and mortality (US Department of Health and Human Services, 1996; Shephard, 1997; Fox, 1999; Booth *et al.*, 2000; Stevens *et al.*, 2002).

Physical inactivity not only contributes to the risk of developing cardiovascular disease, but also Type II diabetes (US Department of Health and Human Services, 1996; Fox, 1999; Dishman *et al.*, 2006; Hillman *et al.*, 2008; Trudeau & Shephard, 2008), osteoporosis (US Department of Health and Human Services, 1996; Dishman *et al.*, 2006; Warburton *et al.*, 2006; Mujović & Čubrilo, 2012) and obesity (US Department of Health and Human Services, 1996; Hillman *et al.*, 2008). This increases the health care costs of the individual (Adler *et al.*, 2007; Bradshaw *et al.*, 2011; Smit *et al.*, 2011) and becomes an economic burden to the government (Adler *et al.*, 2007; Bradshaw *et al.*, 2011).

Fit individuals tend to maintain better nutrition and better body weight (Chomitz *et al.*, 2009) whereas physically inactive people are more likely to become overweight or obese (US Department of Health and Human Services, 1996; Davis *et al.*, 2007; Trost, 2007). Overweight and obesity have become a worldwide epidemic and a huge economic burden (Alonso-Alonso & Pascual-Leone, 2007; Bloemhoff, 2010). Globally more than one billion adults are classified as overweight or obese (Stovitz & Batt, 2010). It is a major problem among university students, with approximately 30 to 35% of students being overweight or obese. Poor dietary habits, disturbed sleeping patterns, increased stress levels and a sedentary lifestyle contribute to being overweight or obese (Ferrara, 2009) whereas physical activity plays an important role in reducing the risk of these conditions developing (Hajian-Tilaki & Heidari, 2006; Burton & Van Heest, 2007; Woodward, 2009; Mujović & Čubrilo, 2012). Research has shown that college students who participate in the recommended levels of moderate or vigorous physical activity gained less weight than students with insufficient levels of physical activity (Sparling & Snow, 2002).

Owing to the pressure on students to perform academically (Coe *et al.*, 2006; Chýlová & Natovová, 2012), as well as the increase in obesity, public attention became focused on physical activity and diet in the academic environment (Chomitz *et al.*, 2009). There is a body of literature that compares the effects of physical fitness on academic performance in children (Sallis *et al.*, 1999; Grissom, 2005; Coe *et al.*, 2006; Castelli *et al.*, 2007; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Kwak *et al.*, 2009; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011), but only very limited research on the effects of physical fitness on academic performance in university students. This study tests the five health-related components of physical fitness, and determines what effect each one has on the academic performance of university students. The five health-related components of physical fitness are cardiovascular endurance, body composition, muscle strength, muscle endurance, and flexibility (ACSM, 2010). Cardiovascular endurance was assessed by means of the Harvard step test. This reliable test is also practical in that a large number of students can be tested simultaneously (Bosco, 1983). The test takes five minutes for male students and four minutes for female students (Phillips & Hornak, 1979). Body composition as a component of physical fitness was measured using the Heath and Carter somatotype method (Krüger & Van Vuuren, 1998). A tape measure, skinfold calliper,

spreading calliper, weighing scale, and a stadiometer were used to take the measurements (Marfell-Jones *et al.*, 2006). The minute sit-up test is a reliable and simple field test used to measure muscle endurance. The subject performs as many sit-ups as possible in a minute (Baechle & Earle, 2008). The grip strength test utilises a hand grip dynamometer and is a valid measure of muscle strength. The hand grip strength test is easy to administer, reliable and relatively inexpensive (Nieman, 2003). The sit-and-reach test is a simple (López-Miñarro *et al.*, 2009) field test for measuring lower back flexibility (Baltaci *et al.*, 2003) and hamstring extensibility (López-Miñarro *et al.*, 2009). The academic performance of the student subjects was measured by taking the average of their semester marks. Ninety nine university students from the faculty of Humanities took part in the study.

The knowledge that fitness has a positive effect on academic performance has implications for university health, education policymakers, research, as well as general education practice (Van Dusen *et al.*, 2011). The aim of this study was to determine which fitness parameters have a positive influence on academic performance and whether or not physical fitness has an effect on academic achievement in university students. If a positive relationship between the two is observed, this research could serve as motivator for the university to provide an environment for students that will enhance academic achievement.

1.2. Problem Statement

1.2.1. High drop-out rates, low retention rates, and low graduation rates

1.2.1.1. High drop-out rates and low retention rates

Student drop-out rates have become a worldwide problem (Letseka & Cosser, 2009), with some institutions having a drop-out rate of 80% (Cignano & Cipollone, 2003; Department of Education, 2005). “Drop-out” implies that a student leaves university prematurely (Hagedorn, 2009) without completing his/her study programme (Daniel *et al.*, 2006). Retention refers to a student remaining at university until he/she has completed his/her study programme (Ministry of Education, 2001; Hagedorn, 2009; Department of Basic Education, 2011). Student drop-out (Hall, 2001) and student retention are complex and multidimensional (Creighton, 2007), and have been a challenge for higher education for decades (Beck *et al.*, 2011). University

management committees are accountable for student retention and completion rates (Ansari & Stock, 2010) and therefore need to find ways to improve student retention as student retention reflects successful student education (Tinto, 2006). According to the Department of Higher Education R4,5 billion was spent by National Treasury on higher education in South Africa between the year 2000 and 2003. This astronomical expenditure resulted from high drop-out rates (Letseka & Maile, 2008). Each year the government spends approximately R1,3 billion in subsidies with a student drop-out rate of 20%. This wasted money could go a long way in expanding higher education (Ministry of Education, 2001). Owing to the significant drop in South Africa's higher education retention rates (Ministry of Education, 2001), it has become a high priority for universities and the new learning and skill sector to find ways to improve the academic performance of students and student retention (Martinez, 2001; Astin, 2005).

The drop-out rate in South African universities is unacceptably high (Department of Education, 2005; Maree, 2008) and on the increase (Beck *et al.*, 2011). It was reported that 45% of contact undergraduate students dropped out in 2004 (Badat, 2010). First year students show the highest percentage of dropping out (Mouton *et al.*, 2013). In 2000, 36 000 of the 120 000 students (in other words, 30%) who had enrolled for a generic bachelor's degree dropped out in their first year of study. A further 30 000 had dropped out by their third year. Of the 60 000 students who remained, only 22% graduated (Department of Education, 2005).

Beck *et al.* (2011) researched the drop-out and retention rates in a sample of National Higher Certificate (NHC) students and found that drop-out rates were unacceptably high and retention rates low. Of the students who had dropped out, 53% were first years. A study by Pierrakeas and Xenos (2004) investigated student drop-out in an undergraduate course in informatics and also found that a higher percentage of younger students drop out compared to older students. According to Breier and Mabizela (2008), 30% of first year students drop out of university. By second or third year a further 20% have abandoned their studies. They found that only 15% of students, who had enrolled, completed their study programme within the designated time. A study by the Human Sciences Research Council (HSRC) showed that of approximately 34 000 students, 20 000 dropped out and only 14 000

graduated. The majority of drop-outs were first year students or second years who were midway through the study year (Eduloan, 2009). From the statistics above, it is clear that student drop-out and retention rates at university are a major concern, and contribute to the crisis in education in South Africa. To improve students' academic performance and reduce student drop-out, it is necessary to identify possible causes of student drop-out and discover possible options to improve students' academic outcomes.

1.2.1.2. Low graduation rates

The graduation rate refers to the total number of students who graduate in a particular year, expressed as a percentage of head count enrolments in the programme in the same year (Ministry of Education, 2001). A low graduation rate is costly to a university in terms of scarce resources, and indicates the university was ineffective in meeting the educational, emotional and social needs of the student (Creighton, 2007). Statistics indicate that few institutions meet the criterion for graduation output (Ministry of Education, 2001; Letseka & Maile, 2008). The Department of Higher Education stated that the graduation rate at some institutions is as low as 6% to 24% (Ministry of Education, 2001). With a pass rate of around 15%, South African universities are considered to have some of the lowest graduation rates in the world (Letseka & Maile, 2008). Between 1993 and 1998 the graduation rate in higher education in South Africa was 15%. Of the 608 000 students who enrolled in higher education in 1998, only 89 000 graduated (Ministry of Education, 2001). The same overall graduation rate between 2004 and 2007 was approximately 16% (Council on Higher Education, 2009), which is almost identical to the graduation rate of 15% between 1993 and 1998 (Ministry of Education, 2001). In 2004, 116 561 students graduated with a higher education qualification from public institutions. This amount increased by 9% in 2007 with 126 641 students graduating (Council on Higher Education, 2009). The poor graduation rates in higher education are cause for concern because they result in fewer high-level skills being produced (Ministry of Education, 2001; Council on Higher Education, 2009). Graduation rates need to be improved to support the social and economic development needs of the country (Mouton *et al.*, 2013). Research indicates that academic preparation and student motivation are the best predictors of whether a student will graduate (Martinez, 2001).

1.2.1.3. Student success

South Africa's education system performs far poorer in international science, mathematics and literacy tests than comparable developing countries, despite South Africa's higher expenditure on education (Simkins *et al.*, 2007). This indicates that the country is not making effective use of resources and that the education system is inefficient (Letseka, 2009). Higher education in South Africa is facing the challenge of improving the student success rate (Strydom *et al.*, 2010). Factors that improve students' success in education have been researched since the 1930s (Strydom & Mentz, 2010) and it has been suggested that universities move to a more holistic approach in order to enhance student success (Ogude *et al.*, 2012). Evidence shows that student satisfaction and success are significantly affected by student engagement. Student engagement refers to students' committing their time to purposeful educational activities (Strydom *et al.*, 2010), and the way in which the institution allocates resources and learning opportunities for students to participate in and benefit from (Kuh *et al.*, 2005). It is therefore important for institutions to ponder how to get students to do things that will make them successful (Strydom & Mentz, 2010) and to put policies and practices in place that can direct students' energy towards appropriate activities (Strydom *et al.*, 2010). The institution needs to create a "menu" of attractive experiences that will give undergraduate students opportunities to participate in useful educational practices for the duration of their studies (Strydom & Mentz, 2010).

1.2.2. Transition from high school to university

The literature indicates that the transition from high school to university is not an effortless one (Cherif & Wideen, 1992; Adlaf *et al.*, 2001; Ferrara, 2009; Amponsah & Owolabi, 2011; Callender *et al.*, 2011; Thawabieh & Qaisy, 2012). Stress levels increase owing to the change in environment (Bray & Born, 2004; Misra & Castillo, 2004; Amponsah & Owolabi, 2011; Callender *et al.*, 2011; Lyrakos, 2012; Thawabieh & Qaisy, 2012; Bataineh, 2013). Changes experienced by first-year students can be academic, physical, social and emotional (Bray & Born, 2004). A study by Cherif and Wideen (1992) examined whether science students experience problems with the transition from high school to university. A questionnaire was distributed in three high schools and three universities in large metropolitan areas in British Columbia and in Washington State. University students, university professors, high school students

and high school teachers were asked to fill in a questionnaire on the transition from high school to university. The results indicated that 59% of the sample strongly agreed that the transition is problematic, 13% believed there was no problem and 22% believed the problem to be a minor one. The majority of professors and first-year students agreed that the change in environment, unlimited freedom and new expectations were the biggest problems.

Students claim that the university setting provides a less structured atmosphere than the high school setting. Universities therefore need to find strategies to bridge the gap between school and university (Ogude *et al.*, 2012). The right mix of resources must be put in place for higher education to succeed (Council on Higher Education, 2009).

1.2.3. Lack of physical activity in university students

Unfortunately the transition from high school to university can be considered a barrier to exercise because of the stress associated with the new environment and the extra workload (Kilpatrick *et al.*, 2005; Gyurcsik *et al.*, 2006; Wengreen & Moncur, 2009).

Research has indicated that the amount of physical activity significantly declines from high school to university (Bray & Born, 2004; Kilpatrick *et al.*, 2005), with two-thirds of university students not being physically active (Haase *et al.*, 2004; Keller *et al.*, 2008). Increasing physical activity among university students can be helpful in preventing obesity and diabetes (MacAuley, 2007; Al-Isa *et al.*, 2011). Physical activity programmes also lead to long-term enhancement of body image (Shephard, 1983; Hausenblas & Symons Downs, 2001; Al-Nader *et al.*, 2013) and build self-esteem (Shephard, 1983; US Department of Health and Human Services, 1996; Hausenblas & Symons Downs, 2001; Ekeland *et al.*, 2004). Good self-esteem is an important component of mental health (Shephard, 1983).

Studies reported that 65% of high school students participate in regular, vigorous physical activity (Grunbaum *et al.*, 2002) compared to only 38% of university students (Douglas *et al.*, 1997). The gap is smaller in respect of regular, moderate activity with 26% of high school students (Grunbaum *et al.*, 2002) and 20% of

university students (Douglas *et al.*, 1997). Moderate intensity exercise refers to physical activity that does not cause one to pant, for example walking briskly, riding a bicycle leisurely or climbing stairs. Vigorous physical activity refers to an activity that causes one to pant, for example running, basketball and aerobic classes (Leslie *et al.*, 2001).

It is suggested that universities develop interventions to increase students' levels of physical activity and should provide leisure activities and facilities that will have a positive effect on the health and lives of students (Tsouros *et al.*, 1998). Promoting exercise among students may also aid in counteracting a reduction in physical activity often reported after graduation (Buckworth, 2001).

1.2.4. Health in university students

Quite a number of students leave home for the first time when they enrol for a tertiary qualification (Stewart-Brown *et al.*, 2000; Sparling & Snow, 2002; Hicks & Heastie, 2008; Bisen, 2012). Free of parental influence they adopt a different lifestyle where health-related habits are often formed (Stewart-Brown *et al.*, 2000). The health and well-being of university students tend to be poorer than the general population (Ansari *et al.*, 2013). According to Palmore (1970), poor health is defined as two or more weeks of bed rest, visiting a doctor more than three times per month, or a stay in hospital for an illness. A person who is free from disease, able to enjoy life and to withstand challenges enjoys positive health. Morbidity, and in extreme cases, premature mortality, is referred to as negative health (US Department of Health and Human Services, 1996).

A large number of university students suffer from mental health problems (Eisenberg *et al.*, 2007). Adlaf *et al.* (2001) reported that university students have higher levels of psychological distress than the general population. Emotional health seems to be a greater problem among students than physical health, with stress on campus increasing at an alarming rate (Amponsah & Owolabi, 2011; Chýlová & Natovová, 2012). Students often experience stress reactions, including anxiety or/and depression (Misra & Castillo, 2004). Amponsah and Owolabi (2011) documented that 70% of students reported having moderate levels of stress. Thawabieh and Qaisy (2012) confirm that a large number of students experience moderate levels of

stress. A study by Stewart-Brown *et al.* (2000) indicated that approximately two-thirds of students were suffering from anxiety which limited their capacity for work and resulted in poor health. High levels of anxiety may also lead to long-standing illness with asthma and musculo-skeletal problems being the most commonly cited causes of physical illness. Utilising university campuses to promote physical activity could potentially benefit student health (Leslie *et al.*, 2001).

The concept of a university where health is actively promoted should be encouraged. This will involve integrating health with the processes and policies of the university and promoting health among students and staff. This will improve students' health and fitness and therefore their ability to perform optimally (Tsouros *et al.*, 1998).

Owing to high drop-out rates, low retention rates and poor health among university students, ways must be investigated to improve students' success and provide an environment conducive to good health.

1.3. Research question

The following research question was used for this study:

Does a relationship exist between physical fitness and academic performance in university students?

1.4. Aim and objectives of the study

The primary objectives of this study were:

- To establish which component of physical fitness will have the greatest positive effect on academic performance;
- To determine the relationship between physical fitness and academic performance in university students;
- To establish whether physical fitness will have an effect on the health of university students; and
- To establish whether health will have an effect on academic performance.

The secondary objective of this study was:

- To establish whether there is a significant difference between the admission point score (AP score) obtained in matric and a student's results at university.

If this study confirms that academic performance is positively influenced by fitness, it can motivate students to become physically more active, as good academic performance is directly related to the number and quality of job opportunities (Kim *et al.*, 2003).

1.5. Research hypothesis

- Cardiovascular endurance will have the greatest positive effect on academic performance of all components of physical fitness.
- Physical fitness will have a positive effect on university students' academic performance.
- Physical fitness will have a positive effect on students' health.
- Healthier students will perform better academically.

1.6. Research design

This is classified as a descriptive correlational study as the researcher determined the association between two or more traits (Thomas & Nelson, 2001).

1.7. Research procedure and strategy

The following research procedure was followed:

- Clearance from the University of Pretoria's Post Graduate Committee
- Approval from the University of Pretoria's Ethics Committee
- Recruitment of participants
- Subjects were tested in January, May and October 2014 which included:
 - Informed consent, indemnity form and physical activity readiness questionnaires (Par-Q)
 - Health screening questionnaire
 - Body composition – Heath and Carter somatotype measurements
 - Cardiovascular endurance test – Harvard step test
 - Muscle strength test – hand grip dynamometer test

- Muscle endurance test – sit-up test
- Flexibility test – sit-and-reach test

→ Use students' cumulative weighted average for the semester

→ Use students' matric AP score

→ Analyse data

→ Interpret results

→ Write the research report

1.8. Structure of thesis

Chapter 1 includes the background to the study, the problem statement, the research question, the aims, objectives, and the research hypothesis. Chapter 2 focuses on the literature, past and present. Chapter 3 contains a detailed description of the methodology used for the study. Chapter 4 gives the results of the statistical analysis. The results are compared with and discussed in terms of the existing literature. Chapter 5 concludes the study and makes recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.1. The role of universities

Universities are large organisations that provide an environment to formally educate students (Douglas *et al.*, 1997; Tsouros *et al.*, 1998). They are a centre of creativity and innovation (Tsouros *et al.*, 1998), characterised by goal ambiguity (Wang, 2010). Universities inform the scope of higher knowledge (Enslin & Pendlebury, 1998), contributing to the growth of an information society in terms of research and skills development (Ministry of Education, 2001). The knowledge gained at university, as well as the high levels of skills, contribute to the political, social, cultural, economic and intellectual life of society, which is rapidly changing (Council on Higher Education, 2000). The key responsibility of a university according to Behr (1985: 107) is “... *to provide a formative scientific education*”.

Universities should strive for excellence, diversity, sustainability and relevance (Ogude *et al.*, 2012). Developing professionals and knowledge workers are necessary to strengthen the country's services, infrastructure and enterprises (Department of Education, 1997). Today's university students are our prospective leaders and policy makers (Leslie *et al.*, 2001; Keating *et al.*, 2005). Their beliefs and attitudes will shape future communities' norms and values (Leslie *et al.*, 2001). Unfortunately, because of high drop-out and low retention rates, there are not enough qualified people to take up the available jobs in South Africa. The lack of qualified people results in exceptionally high levels of unemployment (Kraak *et al.*, 2006; Department of Labour, 2007). Universities therefore need to find ways to improve the academic success of students by promoting high levels of academic achievement and emphasising the importance of academic effort (Strydom *et al.*, 2010). Universities have to produce skilled citizens who can create new knowledge that can be used to improve society as a whole (Van Schalkwyk, 2002). To improve teaching and learning in higher education, South Africa's universities should focus on the five benchmarks of effective education practices. These include the level of academic challenge, interaction between students and staff, active and collaborative

learning, enriching the educational experience, and providing a supportive environment on campus (Strydom *et al.*, 2010).

Higher education in South Africa has undergone fundamental restructuring since the apartheid years, causing universities to face more challenges and tension (Mouton *et al.*, 2013). While trying to contend with declining resources, South African universities also have to deal with students from diverse backgrounds, as well as pressures in respect of quality assurance (Strydom *et al.*, 2010). The primary goal of South Africa's universities is to produce the knowledgeable and skilled graduates needed for the labour market. South Africa's public higher education sector consists of eleven universities, six comprehensive universities, and six universities of technology (Council on Higher Education, 2009).

Providing approximately 50% of the income towards South Africa's higher education, the government has the authority to decide which programmes should be offered at universities (Mouton *et al.*, 2013). Universities need a curriculum that is well suited to the students and the aims of education (Enslin & Pendlebury, 1998; Ministry of Education, 2001; Strydom *et al.*, 2010). Through facilitating curricular reform, the institution may be improving students' level of active participation in their learning (Strydom *et al.*, 2010).

Owing to the pressures universities are under to improve the academic scores of students, the relationship between exercise and academic success must be understood. Universities need to implement the right mix of programmes to improve the academic performance of students (Chomitz *et al.*, 2009). Evidence indicates that the physical activity levels of university students are not sufficient to increase their fitness levels or improve their health (Kilpatrick *et al.*, 2005). Poor health can have a negative influence on students' academic performance (Kim *et al.*, 2003). A university has the ability to affect the health and lives of their students (Douglas *et al.*, 1997; Buckworth, 2001) and should therefore use their influence to benefit the health of society by creating healthy learning and work environments. Universities also need to find ways to improve the mental health and well-being of students as these form an integral part of a healthy university (Callender *et al.*, 2011).

2.2. Academic performance

2.2.1. What is academic performance?

Academic performance is an important variable that effects the advancement of students (Beck *et al.*, 2011). It is the core character in both education and research and the primary indicator to most universities in terms of performance measurement (Wang, 2010). Academic performance refers to a student being able to meet the assessment requirements of the programme for which he/she enrolled. When a student can meet these requirements within the prescribed time, it indicates greater academic success compared to those who need to repeat subjects (Fraser & Killen, 2003). In simple terms, academic performance lies at the root of a university's performance and often reflects whether a university is considered good or bad. Drop-out rates, retention rates and students' study efficiency are indicators of academic performance. The number of degrees or diplomas issued and the number of students who graduate are indicative of educational performance outputs (Wang, 2010).

2.2.2. How is academic performance measured?

Academic performance is assessed by standardised tests or academic grades in an educational setting (Strong *et al.*, 2005; Coe *et al.*, 2006; Tomporowski *et al.*, 2008; Keeley & Fox, 2009; Woodward, 2009; Grais, 2011). It is often quantified by assessing achievement in specific subjects or by means of national assessment tests (Keeley & Fox, 2009). Key measures of academic performance include attendance (Strong *et al.*, 2005; Benner & Graham, 2009), graduation, retention, drop-out rates, suspension rates (Grais, 2011), memory and concentration (Strong *et al.*, 2005).

Behr (1985) and Jawitz (1995) stated that the best single predictor of academic achievement at tertiary level is a student's matriculation results. School performance, rather than intelligence quotient (IQ) tends to be a good predictor of a student's success at university. When a student performs well at school he/she acquires a sound attitude towards work (Behr, 1985).

Studies investigating students' academic achievement have measured factors they deemed related to academic success and correlated these with the average

percentage (Fraser & Killen, 2003; Strong *et al.*, 2005; Benner & Graham, 2009; Trudeau & Shephard, 2010). When examining the relationship between physical fitness and academic performance, academic achievement was often assessed by making use of teacher evaluations (Tomprowski *et al.*, 2008). A study on eight- to twelve-year-old learners used teacher reported conduct grades and examination/test results (Yu *et al.*, 2006). In a cross-sectional survey conducted on 7 961 Australian children aged between seven and fifteen, a school representative had to rate each student's academic ability. The individual learner was rated as being either poor, below average, average, above average, or excellent (Dwyer *et al.*, 2001). However, subjective measures may affect the results since they can be biased and therefore make it more difficult to compare outcomes (Sallis *et al.*, 1999; Van Dusen *et al.*, 2011).

A variety of methods have been used to assess academic success. A number of studies used mathematics, language or reading scores (Tremblay *et al.*, 2000; Eveland-Sayers *et al.*, 2009) when examining the relationship between physical fitness and academic performance. Sigfusdottir *et al.* (2007) used self-reported average grades for mathematics, Icelandic, English and Danish when examining the relationship between self-reported physical activity and self-reported grades in Grade 9 and 10 learners. A study by Du Toit *et al.* (2011), which examined the relationship between physical fitness and academic performance in South African children, used end-of-the-year marks to assess academic achievement, whereas a study by Kwak *et al.* (2009) used 17 school subjects when exploring the relationship between physical fitness and academic achievement in Swedish children and adolescents. Coe *et al.* (2006) used standardised test scores and academic achievement grades for mathematics, English, science, and world studies when assessing academic achievement in 214 6th Grade learners in the USA.

While Castelli *et al.* (2007) used the Illinois Standards Achievement Test to measure academic performance in 3rd and 5th Grade learners in the USA, Chomitz *et al.* (2009) measured academic success in a large group of 4th to 8th Grade learners by means of the Massachusetts Comprehensive Assessment System Achievement tests in English and mathematics. A two year quasi-experimental study conducted in California on 759 learners in grades 4, 5 and 6 used Metropolitan Achievement tests

which are extensively used throughout the USA (Sallis *et al.*, 1999). In 2001 and 2002, a study conducted by the California Department of Education on 884 715 Grade 5, 7 and 9 learners, to establish the relationship between physical fitness and academic performance, used the Stanford Achievement Test, Cognitive Abilities Test (Sixth Edition), and the Standardized Testing and Reporting test (Grissom, 2005). Dwyer *et al.* (1983) evaluated academic success with the GAP reading test and the ACER arithmetic test in ten-year-old learners. Kim *et al.* (2003) measured academic performance in Grade 5, 8 and 11 learners using the grade point average. Two studies assessed academic achievement by means of the Texas Assessment of Knowledge and Skills Test (Welk *et al.*, 2010; Van Dusen *et al.*, 2011). A 16 month study conducted on 287 4th and 5th Grade learners in British Columbia, Canada used the Canadian Achievement Test (Ahamed *et al.*, 2007).

2.2.3. What affects academic performance?

For years South African universities have been looking for strategies to improve the academic performance of students (Ogude *et al.*, 2012). Approximately 48% of a sample of NHC students reported that they had failed a module in their course. This indicates that a reasonable number of students are experiencing academic difficulties (Beck *et al.*, 2011). For this reason it is necessary to identify the various factors that may influence the success students have at university. A student's success can be negatively impacted by a variety of factors that will ultimately influence his/her decision to abandon his/her course. Fortunately many of these factors can be mitigated by physical activity. Academic performance may be influenced by physical (Al-Nader *et al.*, 2013), psychological, social, personal, economic and environmental factors (Mushtaq & Khan, 2012).

2.2.3.1. Physical factors

Research has indicated that physical activity levels and physical fitness may have an effect on academic performance (Dwyer *et al.*, 2001; Kim *et al.*, 2003; Al-Nader *et al.*, 2013). The implementation of physical activity programmes in schools has been shown to improve the attitudes, behaviour, discipline and creativity of learners (Keays & Allison, 1995). Since physical education programmes were reduced in schools, learner drop-out rates, as well as behaviour problems and attention disorders, increased (Shephard *et al.*, 2011). Attention is vital to academic success

(Keeley & Fox, 2009). Studies have indicated that active students have a longer attention span than sedentary students (Shephard, 1997; Coe *et al.*, 2006; Trost, 2007; Chomitz *et al.*, 2009). Shephard (1997) showed that being physically active enhances academic learning per unit of class time. Aerobic fitness (Hillman *et al.*, 2005; Hillman *et al.*, 2008) as well as stretching movements or marching can help improve attention span (Jensen, 1998; Dwyer *et al.*, 2001). Physical activity results in higher levels of endorphins and norepinephrine (Taras, 2005; Al-Nader *et al.*, 2013), both of which play a significant role in attention span and result in positive feelings of happiness and relaxation (Al-Nader *et al.*, 2013). If norepinephrine levels are too low, one tends to feel drowsy, and if they are too high the result is stress (Jensen, 1998). Drowsiness and stress can have a negative influence on academic performance.

Physical activity also increases alertness (Tuckman & Hinkle, 1986), imagination, self-efficacy, emotional stability, conscientiousness (Lichtman & Poser, 1983) enthusiasm, creativity (Tuckman & Hinkle, 1986) and concentration (Shephard, 1983; Caterino & Polak, 1999; Taras, 2005; Trost, 2007), all of which can have a positive effect on academic performance. Research has also shown that physical activity increases alertness (Shephard, 1983; Davranche & Audiffren, 2004), which may enable a learner to pay closer attention in the classroom (Shephard, 1983; Shephard, 1997; Coe *et al.*, 2006).

It has been hypothesised that academic self-concept (DeFreitas & Rinn, 2013) and student motivation could play a big role in academic achievement (Chomitz *et al.*, 2009; Woodward, 2009; Ansari & Stock, 2010). Studies have indicated that physical activity positively influences both self-concept (Taylor *et al.*, 1985; Al-Nader *et al.*, 2013; Ayodele & Adebisi, 2013) and motivation (Kilpatrick *et al.*, 2005). Students who lack motivation show high drop-out rates (Hall, 2001). Students who enjoy university tend to be more motivated and are more likely to make an effort in terms of physical activity and their studies (Talbot, 1990; Castelli *et al.*, 2007). Research has indicated that students who have less confidence in their abilities tend to have less academic success (Taylor *et al.*, 1985; Al-Nader *et al.*, 2013; Ayodele & Adebisi, 2013). Physical activity has been shown to improve an individual's confidence and social skills (Taylor *et al.*, 1985; Al-Nader *et al.*, 2013; Ayodele & Adebisi, 2013). Being physically active gives rise to a sense heightened emotional well-being

(Nelson & Gordon-Larsen, 2006; Al-Nader *et al.*, 2013), a general feeling of well-being (Brown *et al.*, 1978; Shephard, 1983; Al-Nader *et al.*, 2013), and helps people to feel better about themselves (Van Praag, 2008; Keeley & Fox, 2009; Al-Nader *et al.*, 2013).

2.2.3.2. Psychological factors

There are psychological mechanisms that can explain the positive association between physical fitness, cognitive functioning and academic performance (Kwak *et al.*, 2009). Psychological mechanisms refer to an increase in self-esteem through physical activity (Shephard, 1983; Thirlaway & Benton, 1992; Calfas & Taylor, 1994; McAuley *et al.*, 1994; Shephard, 1997; Blumenthal *et al.*, 1999; Tremblay *et al.*, 2000; Ekeland *et al.*, 2004; Nelson & Gordon-Larsen, 2006; Vail, 2006; MacAuley, 2007; Eveland-Sayers *et al.*, 2009; Shephard *et al.*, 2011; Al-Nader *et al.*, 2013). It also refers to a reduction in tension (Eveland-Sayers *et al.*, 2009; Al-Nader *et al.*, 2013), anxiety (Folkins *et al.*, 1972; Brown *et al.*, 1978; Shephard, 1983; Steptoe *et al.*, 1989; US Department of Health and Human Services, 1996; Blumenthal *et al.*, 1999; Fox, 1999; Ekeland *et al.*, 2004; Dishman *et al.*, 2006; Heyward, 2006; Vail, 2006; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Shephard *et al.*, 2011; Al-Nader *et al.*, 2013), stress (Folkins *et al.*, 1972; Shephard, 1983; US Department of Health and Human Services, 1996; Shephard, 1997; Fox, 1999; Dishman *et al.*, 2006; Vail, 2006; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Shephard *et al.*, 2011; Mujović & Čubrilo, 2012; Al-Nader *et al.*, 2013), and depression (Folkins *et al.*, 1972; Brown *et al.*, 1978; Shephard, 1983; Steptoe *et al.*, 1989; US Department of Health and Human Services, 1996; Fox, 1999; Dimeo *et al.*, 2001; Dishman *et al.*, 2006; Heyward, 2006; Vail, 2006; MacAuley, 2007; Eveland-Sayers *et al.*, 2009; Shephard *et al.*, 2011; Al-Nader *et al.*, 2013) as a result of physical activity. All of these factors contribute to a healthy mind (Shephard, 1983) and have an effect on academic performance (Eveland-Sayers *et al.*, 2009; Shephard *et al.*, 2011). The positive association between physical activity and academic performance could be attributed to the fact that physical activity has an impact on psychomotor learning and enhances the process of psychomotor and intellectual development (Shephard, 1983; Shephard, 1997; Tremblay *et al.*, 2000; Eveland-Sayers *et al.*, 2009).

Students have attributed their poor academic performance to their difficulty in recalling information (Beck *et al.*, 2011). This is a concern as working memory is vital to academic success (Keeley & Fox, 2009). Research has indicated that physical activity improves memory (Van Praag *et al.*, 1999; Dik *et al.*, 2003; Sibley & Etnier, 2003; Hillman *et al.*, 2005; Lambourne, 2006; Vaynman & Gomez-Pinilla, 2006; Du Toit *et al.*, 2011; Aye *et al.*, 2013), and facilitates aspects of information processing (Dik *et al.*, 2003; Tomporowski, 2003). Memory, according to Black *et al.* (1990: 5571), is “... *an adaptive change in brain organization brought about by behavioural experience*”. Chang *et al.* (2012) showed that not all aspects of working memory are positively influenced by acute exercise. When cognitive performance was assessed during exercise, a negative effect was seen in subjects with a lower fitness level while a positive effect was viewed in fitter subjects. This could be owing to the fact that fitter people need fewer neural resources for exercise and therefore have more neural resources available for cognitive performance. Lesser fit people need more resources when exercising and therefore have fewer available for cognitive performance. When assessing cognitive performance following exercise, a positive effect was viewed for all fitness levels.

2.2.3.2.1. Mental illness, depression and mood states

Mental disorders and mental illness are universal and on the increase (Fox, 1999), with depression being the most common (Brown *et al.*, 1978). Research indicates that undergraduate students experience elevated levels of psychological disorders and distress (Adlaf *et al.*, 2001). Students who are inactive (Fox, 1999), overweight or obese (Woodward, 2009) and those who have low self-esteem are more likely to suffer from clinical depression (Brown *et al.*, 1978) than active students or students with higher levels of self-esteem. In most developed countries, 5 to 10% of the population suffer from depression (Weissman & Klerman, 1992 cited in Fox, 1999). Mild depression is distinguished by frequent periods of unhappiness (Fox, 1999).

Mental and emotional well-being is considered an important factor in student health (Tsouros *et al.*, 1998). Unfortunately depression is widespread among university students as they face both social and scholastic pressure (Brown *et al.*, 1978). A study by Eisenberg *et al.* (2007) observed that 13,8% of undergraduate students

screened positive for depression and 2,5% reported having suicidal thoughts. Panic disorder and anxiety were also considered a problem among students.

Many studies have confirmed that physical activity improves depression, which in turn has a positive effect on academic performance (Blumenthal *et al.*, 1999; Fox, 1999; Dunn *et al.*, 2005; Etnier *et al.*, 2006; Keeley & Fox, 2009; Miller *et al.*, 2012; Al-Nader *et al.*, 2013). Physical activity is a therapeutic process (Brown *et al.*, 1978; Blumenthal *et al.*, 1999; Driver & Taylor, 2000; Dunn *et al.*, 2005; Al-Nader *et al.*, 2013) and a safe and an effective regime for treating depression (Brown *et al.*, 1978; Fox, 1999). Brown *et al.* (1978) indicated that depressed patients who jogged had a reduction of negative affective states of fatigue, anger, hostility, tension and anxiety. Positive states of energy and cheerfulness were increased significantly. This should encourage depressed students to participate in physical activity as it may positively affect their academic success.

The effect of aerobic exercise on psychological well-being was examined by Moses and associates (1989). Results indicated that moderate physical activity positively influenced psychological responses but high intensity exercise had no effect. Lindwall *et al.* (2012) supports the notion that regular light to moderate exercise is associated with reduced levels of anxiety, depression and burn out, and improves mental health. It was observed that self-reported physical activity is significantly linked to mental health, whereas aerobic fitness is not related.

Physical activity leads to changes in mental functioning (Lichtman & Poser, 1983; Van Praag, 2008) and positively affects mood states (Lichtman & Poser, 1983; Thirlaway & Benton, 1992; US Department of Health and Human Services, 1996; Fox, 1999; Taras, 2005; Nelson & Gordon-Larsen, 2006; Adler *et al.*, 2007; Van Praag, 2008; Keeley & Fox, 2009; Al-Nader *et al.*, 2013). Research supports the notion that “... *exercise makes a person feel good*” (Fox, 1999; Keeley & Fox, 2009) and helps people feel more elated (Tomprowski, 2003). Lichtman and Poser (1983) examined the effects of exercise on mood and cognitive functioning and noticed that physical activity positively influences cognitive functioning and affective states. After exercise subjects felt less sad, depressed, anxious, angry and fatigued. Liao *et al.* (2013) hypothesised that the decrease in depression, stress and anxiety, and the

improvement of self-esteem owing to physical activity contribute to the positive association between physical fitness and academic performance. Steptoe *et al.* (1989) observed that moderate activity rather than high intensity training was associated with improved mood. Goldwater and Collis (1985) concluded that vigorous exercise was associated with larger decreases in anxiety than less vigorous activity. Thirlaway and Benton (1992) examined the effects of physical activity and cardiovascular fitness on mental health and mood. They reported that mood is positively associated with higher levels of physical activity. Changes in fitness levels did not influence psychological responses. This is consistent with the findings of Steptoe *et al.* (1989). Physical activity leads to an increase in cerebral blood flow and increases the body's core temperature, which has also been suggested to increase relaxation and positively affect mood (Fox, 1999). As mentioned previously, physical activity increases serotonin, an exercise-modulated hormone. The calming effect of increased serotonin levels could explain a reduction in disruptive classroom behaviour (Shephard, 1997). It is hypothesised that the positive relationship between physical activity and academic performance could also be explained by the increase in tryptophan, a serotonin precursor, which has a calming effect in students. This would enable the student to sit and concentrate during class (Dwyer *et al.*, 2001).

2.2.3.2.2. Stress and anxiety

Stress is an inescapable phenomenon (Odaci & Çikrikçi, 2012) that has a detrimental effect on a range of brain systems. Stress refers to the pressure and tension an individual experiences when exposed to a situation that threatens or exceeds one's capabilities (Bisen, 2012; Kadapatti & Vijayalaxmi, 2012). When an individual subjectively experiences uncertainty or apprehension it is referred to as anxiety (Baechle & Earle, 2008). Both stress and anxiety are psychologically related issues that students experience at university (Beck *et al.*, 2011). High levels of stress cause atrophy of the brain cells in the hippocampus (Jensen, 1998; Adler *et al.*, 2007). Behaviour (Nelson, 1999), planning, problem solving and the ability to complete complex skills (Hall, 2007) are negatively affected by stress. This in turn influences academic performance, which can cause a student to drop out of university. Taras (2005) stated that physical activity may indirectly influence academic performance by changing one's mood and reducing stress.

University students are at a high risk of developing stress (Adlaf *et al.*, 2001; Bisen, 2012; Odaci & Çikrikçi, 2012) with factors such as inadequate financial resources, overcrowded lecture halls (Bataineh, 2013) and absenteeism contributing to their academic stress (Sigfusdottir *et al.*, 2007; Bataineh, 2013). Other factors contributing to students' stress levels include the pressure to perform well in examinations, expectations from family members, competing with fellow students, workload and low motivation. Juggling work and studies simultaneously also negatively influences stress levels of students (Letseka, 2009). The symptoms of stress include anxiety, nervousness, disturbed sleeping habits and indigestion (Bisen, 2012).

Stress is regarded as an important health problem among university students (Tsouros *et al.*, 1998; Kadapatti & Vijayalaxmi, 2012). Being exposed to stress for long periods of time negatively affects the normal functioning of the cardiovascular, nervous, metabolic and immune systems (Stewart-Brown *et al.*, 2000; Adler *et al.*, 2007). This may result in the development of hypertension, depression and muscle tension (Jensen, 1998), and increases one's susceptibility to infection (Brunner, 1997; Adler *et al.*, 2007). A peptide, known as cortisol, is released when an individual is exposed to stress (Jensen, 1998; Hall, 2007). Physical activity reduces cortisol levels (Hall, 2007), thereby reducing stress and anxiety (Shephard, 1983; Ekeland *et al.*, 2004; Al-Nader *et al.*, 2013). Less stress and anxiety reduces the frequency with which further medical conditions develop, (Shephard, 1983; Fleshner, 2000), which can positively influence academic performance.

2.2.3.2.3. Self-esteem

Self-esteem is the core of mental health and symbolises one's individual rating of overall worth (Fox, 1999). It is considered to be an underlying factor in determining student motivation and academic success (Tremblay *et al.*, 2000). Classroom behaviour is improved with enhanced self-esteem and students with high levels of self-esteem have a greater desire to learn (Bluechardt *et al.*, 1995). Low levels of self-esteem are often linked with poor health behaviours (Fox, 1999). Body image plays a major role in self-esteem (Shephard, 1983). Physical activity has a direct influence on body image (Fox, 1999; Al-Nader *et al.*, 2013) and has been linked to high levels of self-esteem (Nelson & Gordon-Larsen, 2006; Yu *et al.*, 2006). Physical activity improves body image through the reduction of fat mass (Fox, 1999; Mujović

& Čubrilo, 2012) and improved fitness (Fox, 1999), thereby improving one's quality of life overall (Eveland-Sayers *et al.*, 2009).

Tremblay *et al.* (2000) examined the relationship between physical activity, self-esteem, body mass index (BMI) and academic performance in Grade 6 Canadian students. Socio-economic status (SES), family structure and gender were controlled for. Physical activity was measured by means of four questions regarding the student's participation in physical activity at school and outside school. Results from the study indicated that there was a positive relationship between physical activity and self-esteem. As physical activity became more vigorous, self-esteem improved progressively. Physical activity was associated with lower BMI scores, and higher BMI scores were associated with lower levels of self-esteem. The study showed a weak association between physical activity and academic performance. This could be owing to the fact that fitness was self-reported which has been known to lack reliability (Pate *et al.* 1994).

Being overweight is linked to cognitive factors (Alonso-Alonso & Pascual-Leone, 2007; Li *et al.*, 2008), which in turn are associated with academic achievement. A number of studies suggest that overweight children score lower on IQ tests (Campos *et al.*, 1996) and have lower academic achievement scores (Datar & Sturm, 2006; Castelli *et al.*, 2007; Welk *et al.*, 2010) than children within the normal weight range. Li *et al.* (2008) documented that cognitive functioning is decreased in overweight children and adolescents. A study by Cottrell *et al.* (2007) showed that obesity had a significant and inverse relationship with test scores in mathematics, science, social studies, reading/language and art. Results from a study by Du Toit *et al.* (2011) indicated that being overweight had a negative effect on academic performance among girls but not among boys. The percentage of body fat did not influence academic performance. Judge and Jahns (2007) however demonstrated that obese eight-year-old girls did not perform worse academically compared to girls of normal weight, but they argued more and showed more symptoms of depression, such as loneliness. Eveland-Sayers *et al.* (2009) and Ruiz *et al.* (2010) found no significant relationship between BMI and academic scores. However, Welk *et al.* (2010) observed that a normal BMI was positively associated with academic success. Van

Dusen *et al.* (2011) agreed that a moderate BMI was best associated with academic achievement compared to low and high BMI scores.

2.2.3.2.4. Reaction time and executive function

Studies have shown that fitter children perform better in terms of behaviour measures of response accuracy and reaction time than those with lower cardiovascular test scores. This could be owing to the greater allocation of attention resources to working memory (Hillman *et al.*, 2005). Studies demonstrated that reaction time improved when exercising at 50% of maximal aerobic power compared to rest (Davranche & Audiffren, 2004; Davranche *et al.*, 2009). Hillman *et al.* (2005) examined the brain activity of low-fit versus high-fit young adults. The participants performed a visual discrimination task. The results revealed that high-fit children have a greater allocation of attention and faster cognitive processing than low-fit children, which could affect academic performance positively.

Studies confirm that increasing physical activity significantly improves executive function (Kramer *et al.*, 1999; Churchill *et al.*, 2002; Dishman *et al.*, 2006; Zoeller, 2010). Executive function refers to the ability to perform goal-directed actions in complex environments (Tomprowski *et al.*, 2008). It plays an important role in the learning process (Said, 2013) and includes components such as planning, multitasking, scheduling and working (Colcombe & Kramer, 2003; Dishman *et al.*, 2006). Motor skill training improves executive functions of cognition (Dishman *et al.*, 2006). Colcombe and Kramer (2003) conducted a meta-analysis on 18 studies done from 1966 to 2001. They reported that aerobic exercise had a large effect on cognitive performance in adults and that fitness positively influenced executive function. An experiment by Colcombe *et al.* (2004) tested sedentary individuals aged 55 to 77 years. Results showed that a six month aerobic exercise programme led to improved executive function owing to changes in PFC activation. Davis *et al.* (2007) also observed a direct relationship between regular physical activity and improved executive function in children. Results indicated that the high-dose exercise group had improvements in standardised scores for planning.

2.2.3.3. Social factors

Fraser and Killen (2003) examined factors influencing the academic success or failure in first year and senior university students. Students reported that presentations by lecturers were boring, which contributed to students' academic failure. There is evidence that physical activity can counteract boredom (Shephard, 1996; Coe *et al.*, 2006) thereby increasing students' attention span and concentration (Al-Nader *et al.*, 2013). To avoid student withdrawal and unsuccessful completion of courses, universities should address the problems of poorly structured and boring teaching methods (Martinez & Munday, 1998; Martinez, 2001), poor course organisation (Martinez, 2001), and inadequate and weak course design (Martinez & Munday, 1998).

Beck *et al.* (2011) reported that 68% of students procrastinate. This impacts their academic performance negatively as they struggle to meet deadlines in their academic work. Physical activity has been shown to increase energy levels and stamina (Shephard, 1983), which can help the student to be more productive throughout the day. Classroom behaviour also plays a critical role in academic achievement (Trudeau & Shephard, 2008). Research indicated that exercise prior to instructional class time reduces disruptive behaviour in disturbed students (Allison, 1985). Physical activity should therefore be promoted within a learning institution as it may reduce disruptive behaviour, decrease the drop-out rate from the educational programme (Trudeau & Shephard, 2008; Shephard *et al.*, 2011) and result in an improvement in academic performance (Cooper *et al.*, 1999; Trudeau & Shephard, 2008; Al-Nader *et al.*, 2013).

2.2.3.4. Personal factors

Research indicates that academic performance is negatively influenced by increased television watching (Borzekowski & Robinson, 2005; Hancox *et al.*, 2005; Shariff & Sargent, 2006). Individuals who spend more of their time watching television tend to have unhealthy lifestyle habits (Nelson & Gordon-Larsen, 2006), such as sedentary behaviour (Rodenroth, 2010; Fountaine *et al.*, 2011). Ruiz *et al.* (2010) concluded that students who participate in sport did not spend less time studying, but spent less time watching television and playing video games. Participants who spent more time watching television and playing video games spent less time studying. The study

also indicated that those who take part in sport had an increase in muscle and cardio-respiratory fitness whereas those who spend more time watching television and playing video games had lower muscle strength and cardio-respiratory fitness, and a higher BMI. No association was found between muscle fitness and cognitive performance or between BMI and cognitive performance. Wiecha *et al.* (2007) observed that watching television and playing video games resulted in less time spent doing homework and reading. It is therefore recommended that time spent watching television and playing video games be reduced to less than two hours per day. This in turn will lead to an increase in physical activity, which will influence health positively (Strong *et al.*, 2005).

Academic success is influenced by the health of students (Kim *et al.*, 2003). When students are ill they tend to miss class (Jensen, 1998, Keeley & Fox, 2009; Woodward, 2009; Mujović & Čubrilo, 2012), which affects their academic success negatively. Research indicates that a sedentary lifestyle increases the risk of Type II diabetes (US Department of Health and Human Services, 1996; Fox, 1999; Dishman *et al.*, 2006; Hillman *et al.*, 2008; Trudeau & Shephard, 2008) and obesity, which also have the potential to affect academic performance negatively (Kim *et al.*, 2003; Datar & Sturm, 2006; Trudeau & Shephard, 2008). Overweight students have lower self-esteem and a poorer self-image – both of which are determinants of academic achievement (Trudeau & Shephard, 2008; Woodward, 2009). Physical activity reduces the risk of diabetes and obesity (Heyward, 2006; MacAuley, 2007; Al-Isa *et al.*, 2011; Plowman & Smith, 2014), and has a positive effect on overall health (US Department of Health and Human Services, 1996; Warburton *et al.*, 2006).

Research indicates that binge drinking affects academic performance negatively (Ansari & Stock, 2010). Nutrition may also have an effect on academic performance (Kim *et al.*, 2003; Woodward, 2009). Half the students from the study by Beck *et al.* (2011) reported that they do not have enough money to buy food. This is worrying as hungry students struggle to concentrate, which would lead to academic difficulties. A study by Kim *et al.* (2003) evaluated 6 463 Grade 5, 8 and 11 South Korean students to obtain a better understanding of the association between physical activity, dietary behaviours, and SES. No relationship was seen between body weight and academic performance but a weak positive association was demonstrated between physical

fitness and academic performance. Under-nutrition has been negatively associated with cognitive development (Pollitt *et al.*, 1996) while the regularity of meals is positively linked to academic performance (Kim *et al.*, 2003).

A study by Schwartz and Washington (2002) discovered that students' performance and ranking in high school were strong predictors in terms of student retention. Students more likely to return to the next semester were those who had performed better in high school and those who were more motivated. Students who had to repeat a grade in high school are more likely to drop out of university (D'Hombres, 2007; Department of Basic Education, 2011).

Academic factors contributing to academic performance and student drop-out include inadequate time spent preparing for class, inadequate time spent studying (Strydom & Mentz, 2010), the degree of difficulty of courses, inadequate learning material (Pierrakeas & Xenos, 2004), an inability to understand learning material, the wrong choice of programme, and no interest in the topic (Allen, 1993; Pierrakeas & Xenos, 2004). Other factors affecting academic success include students' and lecturers' attitude (Shephard, 1997), the ability of the student (Keeley & Fox, 2009), the student's approach to studying (Meyer *et al.*, 1990; Kadapatti & Vijayalaxmi, 2012), good study habits (Ayodele & Adebisi, 2013) and the way in which the student connects with the institution (Trudeau & Shephard, 2008; Ansari & Stock, 2010). Research indicates that students who connect socially with the university community have a greater chance of retention (Tinto, 1999). Students who set suitable goals (Schmelzer *et al.*, 1987) and those who have self-discipline are more likely to succeed academically (Schmelzer *et al.*, 1987). For a student to be successful he or she needs to have a strong feeling of self-efficacy (Fraser & Killen, 2003, Carroll *et al.*, 2009), determination and purpose, and needs to enjoy academic activity (Fraser & Killen, 2003). Academic achievement may be influenced by the interaction between the student and the lecturer (Lizzio *et al.*, 2002; Fraser & Killen, 2003), the quality of instruction time that the student receives (Lizzio *et al.*, 2002; Rivkin *et al.*, 2005; Keeley & Fox, 2009; Kadapatti & Vijayalaxmi, 2012), learning disabilities, public policy (Castelli *et al.*, 2007), quality of the curriculum (Welk *et al.*, 2010), and cultural expectations (Fraser & Killen, 2003). A study by Du Plessis *et al.* (2005) researched the success predictors in accounting students and reported age,

gender, language, motivation and time management to be predictors of academic success. While Sigfusdottir *et al.* (2007) observed a weak positive relationship between gender and academic performance, Said (2013) confirmed that time management affected academic performance. Woodward (2009) stated that genetics may also have an influence. When assessing the association between physical fitness and academic performance, various studies controlled for gender (Sigfusdottir *et al.*, 2007; Chomitz *et al.*, 2009; Welk *et al.*, 2010), but not for time management. Classroom variables such as class attendance and class size (Fraser & Killen, 2003; Rivkin *et al.*, 2005; Welk *et al.*, 2010; Mushtaq & Khan, 2012) have an effect on academic performance. Schneider (2002) suggested that factors such as noise, light, air quality and temperature may also affect a student's ability to perform academically.

2.2.3.5. Economic factors

SES, which can be determined by a person's status in terms of income, education, occupation and wealth (Considine & Zappalá, 2002; Farooq *et al.*, 2011), has a significant impact on student success (Kim *et al.*, 2003; Davis-Kean, 2005; Toutkoushian & Curtis, 2005; Farooq *et al.*, 2011; Kadapatti & Vijayalaxmi, 2012; Mushtaq & Khan, 2012; Ayodele & Adebisi, 2013). SES can be indicative of better health (Brunner, 1997; Grissom, 2005; Welk *et al.*, 2010) and better living conditions, which may be responsible for higher academic achievement and higher levels of fitness (Grissom, 2005; Welk *et al.*, 2010). Research indicates that students from high to middle income families are more likely to perform better academically than those living in poverty (Davis-Kean, 2005; Grissom, 2005; Coe *et al.*, 2006; Burton & Van Heest, 2007). Families with a higher income can afford healthier food and find recreational facilities where exercise is promoted (Adler *et al.*, 2007).

Studies have indicated that South African students from low income households and those who have less educated families have a higher probability of dropping out of university (Kuh *et al.*, 2007; Letseka & Maile, 2008). This could be owing to the fact that students from lower economic status live in more chaotic homes with less structure and more instability. They suffer more family turmoil and violence, have fewer social support networks and fewer cognitive enrichment opportunities (Evans, 2004). They study in cramped living quarters or under difficult conditions (Letseka &

Maile, 2008). The environments they live in are more polluted and unhealthy (Evans, 2004), which increases their risk of developing chronic conditions such as asthma. They experience more injury and illness and tend to miss class more often (Adler *et al.*, 2007). Those from lower SES families tend to have lower levels of literacy and comprehension; they show higher levels of problematic behaviour, and have lower retention rates (Considine & Zappalá, 2002).

2.2.3.6. Environmental factors

Providing a stimulating home environment has been shown to have an effect on academic performance (Li *et al.*, 2008; Kadapatti & Vijayalaxmi, 2012). Research has indicated that family support and encouragement can have a positive effect on student retention (Dwyer *et al.*, 2001; Pierrakeas & Xenos, 2004; Keeley & Fox, 2009; Welk *et al.*, 2010). Often family members inform their child that dropping out of university is not an option. This places extra stress on the student to avoid failing his/her subjects or dropping out of his/her course (Wintre & Jaffe, 2000). Support from peers can also contribute to academic success (Flook *et al.*, 2005; Ayodele & Adebisi, 2013). Sigfusdottir *et al.* (2007) reported a significant positive association between family structure and academic performance.

Research indicates that student success is influenced by parents' education and income (Sutton & Soderstrom, 1999; Sigfusdottir *et al.*, 2007; Chomitz *et al.*, 2009; Farooq *et al.*, 2011; Mushtaq & Khan, 2012). Students whose parents did not graduate from university had more difficulty in completing university studies successfully compared to other students (DeFreitas & Rinn, 2013). Results from studies have shown that students whose fathers had completed tertiary education were less likely to drop out of university (Cignano & Cipollone, 2003; D'Hombres, 2007). Davis-Kean (2005) noted that parents' education positively influenced their child's academic success owing to the indirect impact of their stimulating home behaviour and the parents' beliefs around achievement. Educated parents may be more efficient teachers at home and help their children with homework (Davis-Kean, 2005). Various studies have incorporated information on SES (Dwyer *et al.*, 2001; Sigfusdottir *et al.*, 2007; Chomitz *et al.*, 2009; Welk *et al.*, 2010), parental education and family structure (Sigfusdottir *et al.*, 2007) in their research. Studies accounting

for SES often used the mother's education as indicator (Kim *et al.*, 2003; Chomitz *et al.*, 2009; Kwak *et al.*, 2009).

2.2.4. What is the admission point (AP) score and how is it calculated?

The AP score system was developed to help potential students determine whether they meet the minimum entry requirements for a course at college or university (<http://www.tut.ac.za/enrol/Admissions/Pages/APS.aspx>). The AP score system assigns point values to the levels of achievement obtained in matric subjects (<http://www.cut.ac.za/admission/>). If a student has more than seven subjects in matric, the seven best subjects are selected to calculate the AP score. If the AP score falls within the testing band, but does not reach the required direct admission score, the student will automatically be allowed to be referred for testing. However, the admission is based on the results achieved in the National Senior Certificate examination (<https://www.nmmu.ac.za/Apply/Admission/APS-Calculator>).

2.3. Cognition

2.3.1. The brain

The adult brain in humans is a critical part of the nervous system (Jensen, 1998) and is able to gain knowledge through experience (Binder *et al.*, 2009). It weighs approximately 1 300 to 1 400 g (Jensen, 1998), which constitutes about 2% of body weight (Davenport *et al.*, 2012). Its most notable characteristic is the folds that form part of the cerebral cortex. The brain is made up of the right and left hemisphere and is divided into the occipital lobe (responsible for vision) (Jensen, 1998; Saladin, 2010), the temporal lobe (responsible for memory, hearing, language and meaning) (Jensen, 1998; Colcombe *et al.*, 2003; Saladin, 2010), the parietal lobe (responsible for processing language and higher sensory functions), and the frontal lobe (involved with problem solving, creativity, judgement and planning) (Jensen, 1998; Saladin, 2010). The rostral part of the frontal lobes of the brain is known as the PFC (Saladin, 2010).

The PFC is very closely associated with areas involved in motor planning (Alonso-Alonso & Pascual-Leone, 2007) and has been linked with critical cognitive processes, including measures of general intelligence (Duncan *et al.*, 1996; Colcombe *et al.*, 2003). It is responsible for learning and problem solving, which are

stimulated through learning complex movements (Sallis *et al.*, 1999). The structure and function of the PFC is shaped by physical activity (Lambourne, 2006; Alonso-Alonso & Pascual-Leone, 2007). Activation of the PFC helps with motor activity. The association between physical activity and the right PFC has been well documented. Activating the right PFC may decrease appetite and promote long term compliance with an exercise programme (Alonso-Alonso & Pascual-Leone, 2007). Clinical syndromes such as schizophrenia have been associated with losses in the PFC (Sowell *et al.*, 2001) while losses in the temporal lobes have been associated with Alzheimer's disease and dementia in elderly people (Colcombe *et al.*, 2003).

The hippocampus (Cotman & Berchtold, 2002) is part of the limbic system (Zoeller, 2010). It is situated in the medial temporal lobe (Jensen, 1998; Kramer *et al.*, 2006) and is responsible for learning, memory (Cotman & Berchtold, 2002; Squire *et al.*, 2004; Kramer *et al.*, 2006; Vaynman & Gomez-Pinilla, 2006) and spatial navigation (Kramer *et al.*, 2006; Zoeller, 2010). A number of genes in the hippocampus are regulated through exercise (Cotman & Berchtold, 2002). The size of the anterior hippocampus increases with aerobic exercise training, which results in improved spatial memory (Kempermann *et al.*, 1997; Kempermann *et al.*, 1998).

Oxygen is vital to the brain (Jensen, 1998). Physical activity improves the oxygen supply to the brain, which increases one's capacity to learn (Rodenroth, 2010, cited in Gallery, 2002), and helps the individual make decisions (Rodenroth, 2010). If the brain's blood supply is interrupted, it results in loss of consciousness (Jensen, 1998).

2.3.2. The association between cognitive function and physical activity

Cognitive function refers to a number of fundamental mental processes (Tomprowski *et al.*, 2008; Saladin, 2010) with the ability to select, store, retrieve and integrate information (Cupples & Stilley, 2005). Components of cognition are active throughout life (Nelson, 1999) and include attention, working memory, reaction time and stimulus response (Keeley & Fox, 2009). A link has been reported between physical fitness and performance in terms of cognitive and perceptual skills, as well as tasks (Van Praag *et al.*, 1999). Research indicates that exercise improves cognitive function of the young, the elderly and those with intellectual disability (Pastula *et al.*, 2012).

A body of literature has examined the association between physical fitness and cognitive functioning (Hillman *et al.*, 2005; Etnier *et al.*, 2006; Hillman *et al.*, 2008; Tomporowski *et al.*, 2008; Shelton, 2009). Both human and animal studies confirmed that regular exercise alters brain structure and the brain functions responsible for cognition and behaviour (Van Praag *et al.*, 1999; Kramer *et al.*, 2002; Colcombe *et al.*, 2004; Kramer *et al.*, 2006; Pereira *et al.*, 2007; Aberg *et al.*, 2009; Huang *et al.*, 2013). Physical activity and fitness increase brain mass (Kramer *et al.*, 2002; Hillman *et al.*, 2008; Du Toit *et al.*, 2011), and improve brain health (Colcombe *et al.*, 2003; Dishman *et al.*, 2006; Chomitz *et al.*, 2009; Al-Nader *et al.*, 2013) and mental health (Thirlaway & Benton, 1992; Taras, 2005; Keeley & Fox, 2009). It is closely associated with a number of mental benefits (Laurin *et al.*, 2001; Barnes *et al.*, 2003; Colcombe & Kramer, 2003; Sibley & Etnier, 2003; Dishman *et al.*, 2006; Etnier *et al.*, 2006; Al-Nader *et al.*, 2013), and positively influences cognition (US Department of Health and Human Services, 1996; Etnier *et al.*, 1997; Fox, 1999; Laurin *et al.*, 2001; Churchill *et al.*, 2002; Barnes *et al.*, 2003; Colcombe & Kramer, 2003; Dik *et al.*, 2003; Sibley & Etnier, 2003; Hillman *et al.*, 2005; Dishman *et al.*, 2006; Etnier *et al.*, 2006; Kramer *et al.*, 2006; Vaynman & Gomez-Pinilla, 2006; Burton & Van Heest, 2007; Castelli *et al.*, 2007; MacAuley, 2007; Winter *et al.*, 2007; Hillman *et al.*, 2008; Tomporowski *et al.*, 2008; Van Praag, 2008; Chomitz *et al.*, 2009; Du Toit *et al.*, 2011; Davenport *et al.*, 2012; Al-Nader *et al.*, 2013; Aye *et al.*, 2013; Huang *et al.*, 2013). Physical fitness leads to changes in brain-derived neurotransmitter activity (Herholz *et al.*, 1987; Shephard, 1997; Cotman & Berchtold, 2002; Eveland-Sayers *et al.*, 2009), which may explain the improvements in cognitive functioning.

A meta-analysis of 44 studies showed that physical activity is positively linked to improved cognitive functioning in children. The type of exercise did not seem to influence the results (Sibley & Etnier, 2003). Tomporowski *et al.* (2008) and Trudeau and Shephard (2008) observed that fitter children perform cognitive tasks more efficiently than less fit children. Barnes *et al.* (2003) examined whether baseline measures of cardiorespiratory fitness were linked to cognitive function maintenance over a six year period. A positive relationship was reported. Yaffe *et al.* (2001) showed that cognitive performance improved with an increase in reported levels of activity. A cohort of over one million Swedish men in the military were recruited to examine the cross-sectional and longitudinal association between physical fitness

and cognitive function. In 18-year-old men, aerobic fitness was positively linked with performance in logic and verbal intelligence tests (Aberg *et al.*, 2009).

Physical fitness has been shown to maintain or improve cognitive function in older adults and elderly people (Colcombe & Kramer, 2003; Dishman *et al.*, 2006; Kramer *et al.*, 2006; Zoeller, 2010). It is thought that the increase in blood flow may delay the cognitive declines caused by the aging process (Churchill *et al.*, 2002). A meta-analysis examining the effect of exercise training in older adults with cognitive impairment and dementia concluded that exercise training was positively associated with health, physical, cognitive, behavioural and functional components (Heyn *et al.*, 2004). Colcombe and Kramer (2003) conducted a meta-analysis on 18 intervention studies to examine the association between aerobic fitness and cognition in sedentary older adults. Results indicated that fitness had a significant effect on cognition. The length, type and duration of the fitness training programme determined the extent of benefits on cognition. Kemoun *et al.* (2010) reported that a 15-week physical activity programme slowed down the decline in cognitive functioning and improved the quality of walking in aged persons suffering from dementia (Kemoun *et al.*, 2010). This study was in agreement with previous research that had demonstrated that stamina based exercises, such as walking and ergocycle, improved overall cognitive functioning in healthy elderly people (Colcombe *et al.*, 2003) and in elderly patients suffering from dementia (Kemoun *et al.*, 2010).

Studies have indicated that cognition is positively influenced by cardio-respiratory fitness (Barnes *et al.*, 2003; Colcombe & Kramer, 2003). For improvements in mental health, the literature recommends moderate intensity exercise for 30 minutes or more (Fox, 1999), five or six days a week. Zoeller (2010) stated that aerobic and strength training that lasted 30 minutes or more at a time, for a duration of more than six months resulted in the greatest benefit in terms of cognitive function. Colcombe and Kramer (2003) reported that positive gains in cognitive performance can appear within a short time. They also concluded that less than 30 minutes of exercise has a limited impact on cognitive performance. Findings obtained by Pastula *et al.* (2012) indicated that exercising at 60 to 70% of maximum heart rate effectively improved the cognitive functioning of intellectually disabled young adults. In its conclusion, the study stated that moderate intensity exercise benefits both physical and mental

health. It is assumed that aerobic type exercise, which includes cycling, running, or brisk walking, has a positive effect on cognitive ability whereas anaerobic exercise such as stretching and toning exercise does not have the same effect (Miller *et al.*, 2012).

2.4. Physical activity and physical fitness

Physical activity consists of an intricate mix of behaviours (US Department of Health and Human Services, 1996; Malina, 2001; Keeley & Fox, 2009; Lindwall *et al.*, 2012). When skeletal muscles contract to produce a body movement that results in the expenditure of energy, it is referred to as physical activity (Caspersen *et al.*, 1985; US Department of Health and Human Services, 1996; Garcia *et al.*, 1998; Malina, 2001; Dishman *et al.*, 2006; MacAuley, 2007; Trudeau & Shephard, 2010). Exercise is a form of physical activity that is structured and repetitive and helps to maintain or improve physical fitness (US Department of Health and Human Services, 1996; Dishman *et al.*, 2006; MacAuley, 2007). Estimates of physical activity can be obtained by means of interviews, questionnaires, and heart rate integrators (Malina, 2001; Ainsworth, 2009). Epidemiological studies have used a variety of techniques such as surveys (Caspersen *et al.*, 1985), diaries, recall, global self-reports and logs to classify physical activity levels (US Department of Health and Human Services, 1996). Sigfusdottir *et al.* (2007) used self-report questions to measure physical activity when examining health behaviour and academic achievement in school children in Iceland. However, direct measurements of physical activity by means of electronic or mechanical devices or physiological measurements are more accurate and therefore preferred (US Department of Health and Human Services, 1996).

On average, males are physically more active than females (Malina, 2001; Bloemhoff, 2010). In 2008, the World Health Organization (WHO) noted that 46,4% males, and 55,7% females were not sufficiently physically active (WHO, 2010). Lack of physical activity is a major problem in South Africa with 48% of adult men and 63% of adult woman being categorised as inactive (Department of Health, 2007). A study conducted by Smit *et al.* (2011) indicated that the majority of South African women fell in the low physical activity group. According to the WHO, being physically unfit is the fourth leading cause of death. Individuals who participate in 30 minutes of

moderate intensity physical activity have a 20–30% reduced risk of all-cause mortality compared to sedentary individuals (WHO, 2010).

Barriers associated with physical activity include age, personality, knowledge, peer pressure (Rodenstock *et al.*, 1988), and a lack of time and motivation (Quadros *et al.*, 2009; Al-Isa *et al.*, 2011). A study by Gyurcsik *et al.* (2006) reported that university students experienced more barriers to exercise than high school learners. These included intrapersonal, institutional and interpersonal barriers. Intrapersonal barriers refer to the characteristics of the individual such as a negative attitude to exercise or a lack of motivation (McLeroy *et al.*, 1988; Gyurcsik *et al.*, 2006). It also refers to the individual's skills, knowledge and behaviour (McLeroy *et al.*, 1988). Institutional barriers refer to the characteristics of the institution such as not providing an environment for students to exercise. Interpersonal barriers refer to social networks and support systems (McLeroy *et al.*, 1988; Gyurcsik *et al.*, 2006). Barriers to exercise may prevent a student from having an active lifestyle. This causes a student to become physically unfit, which can contribute to health problems. Other factors contributing to physical activity behaviour include gender, ethnicity, history of physical activity, and enjoyment derived from physical activity (Keating *et al.*, 2005).

A study by Lovell (2010) examined the perceived benefits of and barriers to exercise in inactive female university students and showed that physical exertion was the greatest perceived barrier to exercise. Time expenditure and family discouragement were also classified as barriers to exercise. Some students admitted to being too embarrassed to exercise, while others felt that exercise was hard work and took too much time away from their family relationships. The greatest perceived benefit of exercise was physical performance, which includes health aspects such as physical appearance, physical fitness, stamina and muscle tone. A systematic approach to alleviate barriers to physical activity is needed at universities. A study by Kilpatrick (2005) observed that male university students are more likely to be motivated by ego-related factors such as competition, strength and endurance than female university students, and view exercise as an opportunity to achieve these ego-related goal outcomes. They are stimulated by performance and social recognition.

Physical fitness is a physiological state of well-being (Plowman & Smith, 2014) and refers to a complex set of functional capabilities and capacities (Keeley & Fox, 2009). Physical fitness is the ability to perform physical activity (Caspersen *et al.*, 1985; Heyward, 2006) and daily tasks with alertness and vigour, and without excessive fatigue (US Department of Health and Human Services, 1996; Heyward, 2006). Being physically fit reduces the risk of hypokinetic diseases, which are diseases caused by a lack of physical activity (Plowman & Smith, 2014). Studies have indicated that fitness levels may be linked to emotional, social and environmental factors (Cottrell *et al.*, 2007). Physical fitness can be divided into health-related and performance-related fitness. Health-related fitness includes cardio-respiratory or cardiovascular endurance, muscle strength, muscle endurance, body composition, and flexibility (US Department of Health and Human Services, 1996; Heyward, 2006; MacAuley, 2007; Tomporowski *et al.*, 2008; Keeley & Fox, 2009; Plowman & Smith, 2014). These five components form the core of aerobic fitness (Plowman & Smith, 2014). Performance-related fitness includes balance, agility, speed and reaction time (US Department of Health and Human Services, 1996; MacAuley, 2007; Plowman & Smith, 2014). Exercise training is a method designed to improve the specific dimensions of physical fitness (Tomporowski *et al.*, 2008). Studies have shown that certain components of physical fitness may influence academic performance whereas other components have no significance (Dwyer *et al.*, 2001; Castelli *et al.*, 2007; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Du Toit *et al.*, 2011). Cardiovascular fitness and body composition have generally been shown to have the strongest association with academic performance. This could be because these two components are strongly associated with risk factors for chronic disease (Van Dusen *et al.*, 2011).

Measuring the components of physical fitness is valuable as it helps students to understand the benefits of maintaining an active lifestyle (Woodward, 2009). The components of physical fitness are measured using a battery of tests (Keeley & Fox, 2009) that are highly accurate and reliable (US Department of Health and Human Services, 1996). Fitness can be measured using laboratory tests as well as field tests; however, field tests are often preferred as they can be performed anywhere (Plowman & Smith, 2014). When examining the relationship between physical fitness and academic performance, fitness was often measured using the FitnessGram

(Grissom, 2005; Castelli *et al.*, 2007; Welk *et al.*, 2010; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011). The FitnessGram was developed by the Cooper Institute for Aerobics Research and provides a reliable and valid measurement of fitness (Castelli *et al.*, 2007). It measures five aspects, namely aerobic capacity, body composition, trunk strength, upper body strength and flexibility (Grissom, 2005). Chomitz *et al.* (2009) made use of aerobic endurance, BMI, abdominal strength, upper body strength and flexibility to measure overall physical fitness, and included agility. Dwyer *et al.* (2001) measured physical activity and physical fitness using a questionnaire and indoor and outdoor fitness tests.

2.4.1. Physical activity levels in university students

Physical activity declines with age (Malina, 2001). Studies indicate that the biggest decline in physical activity occurs during adolescence (between the ages of 15 and 19) and young adulthood (20 to 25) (Leslie *et al.*, 2001; Malina, 2001; Gyurcsik *et al.*, 2006). Research has indicated that the physical activity levels of university students is low (Keating *et al.*, 2005), with more than half of university students not meeting the minimum requirement of physical activity (Ferrara, 2009).

Keating *et al.* (2005) have shown that approximately 30–50% of students do not participate in the recommended levels of activity necessary to obtain health benefits, while Sparling and Snow (2002) have indicated that only 34,3% of college students participated in the recommended levels of moderate and high intensity exercise. Those who had engaged in the recommended levels of physical activity picked up less weight after graduation than those who had been inadequately active. Irwin (2007) had similar findings. Only 35% of university students participated in the recommended levels of physical activity necessary for health benefits. A survey conducted by Douglas *et al.* (1997) demonstrated that 36% of university students were not involved in adequate physical activity. This correlated with the studies mentioned above. Bloemhoff (2010) reported that 33% of students are inactive, irrespective of gender or race. Bray and Born (2004) reported that 66% of their sample of first year university students had participated in sufficient physical activity during high school. This dropped to 44% during the transition period from high school to university. These results are worrying as physical inactivity increases the risk of health problems (US Department of Health and Human Services, 1996;

Baranowski *et al.*, 1997; Garcia *et al.*, 1998; Stone *et al.*, 1998; US Department of Health and Human Services, 2000; Leslie *et al.*, 2001; Malina, 2001; Gyurcsik *et al.*, 2006) and increases mortality (US Department of Health and Human Services, 1996; Shephard, 1997; Fox, 1999). Adults who exercise regularly tend to adopt other positive healthy habits (Pate *et al.*, 1996) and are less likely to participate in behaviours that pose a risk to health (Nelson & Gordon-Larsen, 2006). They are more likely to follow healthier diets, maintain a healthier body composition (Blair *et al.*, 1985; Simoes *et al.*, 1995), tend to smoke less and use less alcohol (Blair *et al.*, 1985; Simoes *et al.*, 1995; Nelson & Gordon-Larsen, 2006). Owing to the high levels of physical inactivity among university students, strategic interventions need to be developed to improve their health status and reduce their risk of chronic disease (Bloemhoff, 2010).

2.5. Physical activity and health

Our genes rely on physical activity to function normally (Booth *et al.*, 2000; Heyward, 2006). Unfortunately the amount of physical activity performed daily has reduced dramatically over the past century (Booth *et al.*, 2000), despite the numerous physiological and psychological benefits of physical activity (Brown *et al.*, 1978; US Department of Health and Human Services, 1996; Shephard, 1997; Jensen, 1998; Fox, 1999; US Department of Health and Human Services, 2000; Hausenblas & Symons Downs, 2001; Grissom, 2005; Keeley & Fox, 2009; Rodenroth, 2010; Shephard *et al.*, 2011; Miller *et al.*, 2012). Physical activity decreases all-cause mortality significantly (Shephard, 1997; MacAuley, 2007; Bloemhoff, 2010; Plowman & Smith, 2014) and leads to improved fitness, which reflects overall better health (Palmore, 1970; Taras, 2005; Chomitz *et al.*, 2009; Plowman & Smith, 2014). Overall better health contributes to better academic results (Chomitz *et al.*, 2009).

The interaction between the duration, intensity and frequency of exercise will determine the overall effect on an individual's health (Keating *et al.*, 2005). Research indicates that moderate intensity physical activity is required to promote overall health and prevent disease (Strong *et al.*, 2005; Heyward, 2006). It is recommended that all adults engage in moderate intensity exercise for at least 30 minutes or more on most, if not all days of the week (Pate *et al.* 1994; Strong *et al.*, 2005; Townsend *et al.*, 2012; Plowman & Smith, 2014), using the large muscle groups (US

Department of Health and Human Services, 1996; Townsend *et al.*, 2012). The guidelines of Plowman and Smith (2014) and Heyward (2006) correlate with those of the WHO (2010) that recommend 150 minutes of moderate intensity exercise per week for adults over 18 years of age, or vigorous intensity exercise of 75 minutes or more per week for health benefits. The risk of colon and breast cancer is reduced significantly by engaging in 30–60 minutes' physical activity daily (WHO, 2010).

With more and more people becoming sedentary (Booth *et al.*, 2000; Heyward, 2006; Rodenroth, 2010; Mujović & Čubrilo, 2012) the risk of chronic disease has risen (Heyward, 2006). Physical inactivity (Booth *et al.*, 2000; Mujović & Čubrilo, 2012) and inappropriate diet are the two strongest predisposing factors of chronic disease (Booth *et al.*, 2000), with physical inactivity resulting in approximately 3,2 million deaths per year (WHO, 2010). Chronic disease refers to disease that is slow in progress and long in duration (Dorland, 1974, cited in Booth *et al.*, 2000). Coronary heart disease, Type II diabetes, stroke, hypertension, cancer, obesity and osteoporosis are examples of chronic disease (Booth *et al.*, 2000; Bradshaw *et al.*, 2011), all of which can be reduced by means of physical activity (US Department of Health and Human Services, 1996; Booth *et al.*, 2000; Heyward, 2006; Warburton *et al.*, 2006; MacAuley, 2007; Keeley & Fox, 2009; WHO, 2010; Mujović & Čubrilo, 2012). Studies have indicated that the prevalence of chronic disease is less in societies where physical work is largely performed every day. The incidence of chronic disease has increased drastically (Booth *et al.*, 2000) in developed countries where exercise is being omitted from lifestyles and replaced by technology (Heyward, 2006; Woodward, 2009; Rodenroth, 2010). Owing to the increase in the use of computers on campus, students spend less time being physically active and more time sitting (Leslie *et al.*, 2001; Fountaine *et al.*, 2011).

Physical activity reduces the risk of a wide variety of age-related diseases (Radák *et al.*, 2001; Dishman *et al.*, 2006) and has a positive effect on the cardiovascular, respiratory, musculoskeletal (US Department of Health and Human Services, 1996; Jensen, 1998) and endocrine systems (US Department of Health and Human Services, 1996). It also plays an important role in strengthening the immune system (Dishman *et al.*, 2006). The immune system is an adaptive system that provides surveillance against viruses, bacteria and foreign proteins (US Department of Health

and Human Services, 1996; Plowman & Smith, 2014). Research has shown that students' immune systems are depressed during test time (Jensen, 1998). Physical activity should therefore be encouraged throughout the year, including during exams, as it reduces tension, anxiety and stress (Eveland-Sayers *et al.*, 2009; Al-Nader *et al.*, 2013) and strengthens the immune system (Dishman *et al.*, 2006), which could influence academic success positively.

Cardiovascular disease affects the heart and blood vessels (MacAuley, 2007) and is a major cause of death worldwide (Bleske *et al.*, 2011). Cardiovascular disease was the leading cause of terminal non-communicable disease (NCD) (also known as non-infectious disease) in 2008, accounting for 17 million or 48% of NCD deaths (WHO, 2010). A study by Bleske *et al.* (2011) showed that cardiovascular risk factors are evident in young educated people. These risk factors include obesity, dyslipidemia, hypertension, diabetes mellitus, cigarette smoking and physical inactivity (Heyward, 2006; Plowman & Smith, 2014). Evidence indicates that physical activity and healthy dietary habits are primary prevention strategies in the prevention of cardiovascular disease in the youth (Kelder *et al.*, 1994; Tremblay *et al.*, 2000; MacAuley, 2007; Mujović & Čubrilo, 2012). Physical fitness is a strong predictor of cardiovascular health (Warburton *et al.*, 2006) and reduces the risk of heart disease (Shephard, 1997; Fox, 1999; Barnes *et al.*, 2003; Warburton *et al.*, 2006) and heart failure (Dishman *et al.*, 2006). Çuhadar *et al.* (2013) observed that the risk of coronary heart disease was lower in young adult males who participated in high levels of physical activity than in less active young adult males.

During their first semester at university, approximately 25% of students pick up a significant amount of weight (Wengreen & Moncur, 2009), which can negatively affect self-esteem (Kilpatrick *et al.*, 2005). Effective strategies need to be put into place to assist these students to maintain a healthy body weight (Wengreen & Moncur, 2009) as individuals of normal weight get ill less often than those who are overweight or underweight (Palmore, 1970). Overweight and obesity is a major health risk (Plowman & Smith, 2014) increasing the risk of morbidity and mortality (Stevens *et al.*, 2002). It is a risk factor for cardiovascular disease (Tremblay *et al.*, 2000) increasing the probability of hypertension, diabetes, depression and anxiety (Woodward, 2009; WHO, 2010; Plowman & Smith, 2014). It also increases the risk

of developing NCD (Hajian-Tilaki & Heidari, 2006; Bradshaw *et al.*, 2011), such as stroke, cancer and asthma (MacAuley, 2007; Bradshaw *et al.*, 2011). The rise of NCD in South Africa has a negative impact on productivity (Bradshaw *et al.*, 2011). NCD can be modified through regular activity and healthy eating habits (MacAuley, 2007; Bradshaw *et al.*, 2011). Unfortunately when students become overweight or obese, they are less likely to take part in physical activity (Al-Isa *et al.*, 2011). Overweight or obese individuals find physical activity difficult, and not as enjoyable as people within the healthy weight range (Woodward, 2009).

Obesity has been recognised by the WHO as a chronic disease (Van Der Merwe & Pepper, 2006). Approximately 2,8 million people die each year because they are overweight or obese (WHO, 2010). In South Africa obesity has increased drastically over the past 25 years resulting in an increase in the risk of comorbid disease (Van Der Merwe & Pepper, 2006). In particular, overweight and obesity levels in South African woman are exceptionally high (Van Der Merwe & Pepper, 2006; Wengreen & Moncur, 2009; Bradshaw *et al.*, 2011). In 2008, the age-standardised adjusted estimate for overweight South African adults over the age of 20 years was 68% for both sexes (WHO, 2010). In 1998, 29% South African men and 57% South African woman were classified as overweight or obese (Van Der Merwe & Pepper, 2006). Obesity refers to an excess of adipose tissue (US Department of Health and Human Services, 1996). A person is considered overweight when their BMI is between 25 and 30 kg.m⁻², and obese when it is 30 kg.m⁻² or above (Heyward, 2006; MacAuley, 2007; Bradshaw *et al.*, 2011; Plowman & Smith, 2014). A sedentary lifestyle is a major contributor to obesity (US Department of Health and Human Services, 1996; Davis *et al.*, 2007; Trost, 2007).

Obesity in childhood increases the risk of chronic disease in adulthood (Welk *et al.*, 2010). Because of its huge toll on the nation's health, physical activity is becoming of great importance (Stevens *et al.*, 2002). Regular physical activity reduces body fat (Booth *et al.*, 2000; Stevens *et al.*, 2002; Burton & Van Heest, 2007; Mujović & Čubrilo, 2012) and also has a positive effect on the distribution of body fat (US Department of Health and Human Services, 1996), preventing the onset of obesity which has become a world-wide epidemic (Shephard, 1997; Booth *et al.*, 2000; Stevens *et al.*, 2002; Strong *et al.*, 2005; Heyward, 2006; Van Der Merwe & Pepper,

2006; Burton & Van Heest, 2007; MacAuley, 2007; Woodward, 2009; Mujović & Čubrilo, 2012; Plowman & Smith, 2014). If the trend of being overweight is not reversed, physical inactivity and unhealthy eating habits may soon become the leading preventable causes of death, overtaking tobacco (Mokdad *et al.*, 2004). It has been shown that women are 60% less likely to be obese if they exercise three to four hours per week compared to being sedentary (Hajian-Tilaki & Heidari, 2006). It is therefore necessary to encourage lifelong, regular physical activity in order to gain numerous health benefits and reduce the risk of obesity (US Department of Health and Human Services, 1996; Booth *et al.*, 2000; Burton & Van Heest, 2007; MacAuley, 2007).

Diabetes (Bradshaw *et al.*, 2011; Khashayar *et al.*, 2013; Plowman & Smith, 2014) and hypertension are associated with obesity (Bradshaw *et al.*, 2011). Like obesity, Type II diabetes (also known as non-insulin dependent diabetes mellitus) has reached epidemic proportions (Booth *et al.*, 2000; Van Der Merwe & Pepper, 2006; Plowman & Smith, 2014). Physical inactivity is associated with non-insulin dependent diabetes mellitus. Insulin resistance is associated with cognitive impairment (US Department of Health and Human Services, 1996; Vaynman & Gomez-Pinilla, 2006). This could be owing to the fact that insulin is used by the brain structures responsible for learning and memory (Vaynman & Gomez-Pinilla, 2006). Physical activity is one of the most effective therapies for individuals with insulin resistance (Booth *et al.*, 2000; Heyward, 2006; Plowman & Smith, 2014) and Type II diabetes (US Department of Health and Human Services, 1996; Fox, 1999; Booth *et al.*, 2000; Barnes *et al.*, 2003; Warburton *et al.*, 2006; MacAuley, 2007; Mujović & Čubrilo, 2012). Exercise increases insulin sensitivity, as well as the uptake of glucose by the skeletal muscle (Booth *et al.*, 2000; Mujović & Čubrilo, 2012).

Physical fitness reduces the risk of cerebrovascular disease (Shephard, 1997; Barnes *et al.*, 2003) and stroke, and is an effective treatment method for several diseases (Keeley & Fox, 2009), such as some cancers (US Department of Health and Human Services, 1996; Fox, 1999; Booth *et al.*, 2000; Warburton *et al.*, 2006; MacAuley, 2007; Plowman & Smith, 2014) including colon cancer (US Department of Health and Human Services, 1996; Booth *et al.*, 2000; Plowman & Smith, 2014). Physical activity is also associated with energy metabolism (Vaynman & Gomez-

Pinilla, 2006), and regulates disease-related genes such as lipoprotein lipase which is responsible for lipoprotein metabolism (Booth *et al.*, 2000). Regular physical activity leads to a reduction in the development of hyperlipidemia (Shephard, 1997; Heyward, 2006; Cowan & Nash, 2010) and hypertension (Shephard, 1997; Barnes *et al.*, 2003; Dishman *et al.*, 2006; MacAuley, 2007; Mujović & Čubrilo, 2012; Plowman & Smith, 2014). Physical activity maintains skeletal mass, healthy joints (US Department of Health and Human Services, 1996; Strong *et al.*, 2005; Warburton *et al.*, 2006), bone mass (Mujović & Čubrilo, 2012), and a strong body (Adler *et al.*, 2007) thereby delaying the onset of osteoporosis (Warburton *et al.*, 2006; Mujović & Čubrilo, 2012). It improves balance (MacAuley, 2007), endurance, strength, flexibility and co-ordination (MacAuley, 2007; Mujović & Čubrilo, 2012), and has a significant influence on general well-being. Physical activity improves one's quality of life (Brown *et al.*, 1978; Shephard, 1983; Mujović & Čubrilo, 2012; Al-Nader *et al.*, 2013).

Insomnia affects approximately one third of the adult population and negatively affects work performance (Fox, 1999). Sleep deprivation and poor quality sleep are common in university students (Gilbert & Weaver, 2010). A study conducted by Ansari and Stock (2010) reported that 20% of students suffered from insomnia or from a sleeping disorder. Irregular sleep patterns in students can result in drowsiness, can have a negative effect on concentration level, and can result in an increase in stress levels (Matsumoto *et al.*, 2011). This in turn has a negative impact on academic performance (Eisenberg *et al.*, 2007; Ansari & Stock, 2010; Gilbert & Weaver, 2010; Matsumoto *et al.*, 2011). Inadequate sleep is a significant health problem (Gilbert & Weaver, 2010), which has been shown to increase blood pressure, pulse rate and waist circumference in male university students (Matsumoto *et al.*, 2011). Being deprived of sleep can imitate depressive symptoms such as fatigue and irritability (Gilbert & Weaver, 2010). Many studies have shown that physical activity leads to improved sleep habits (Baekeland & Lasky, 1966; Fox, 1999; Driver & Taylor, 2000; Etnier *et al.*, 2006), which have been shown to affect academic performance positively (Etnier *et al.*, 2006) and benefit physical and mental health (Matsumoto *et al.*, 2011).

With the large increase in the number of diseases in modern times (Mujović & Čubrilo, 2012), strategies are needed to encourage the population to become

physically active, which in turn will reduce the risk of chronic disease. It is recommended that lifestyle forms of physical activity such as gardening, walking and accessible and safe cycling paths be used by individuals to achieve health-related and fitness goals (WHO, 2010). Motivating university students to be physically active not only has a positive effect on their overall health (Tremblay *et al.*, 2000; Biddle *et al.*, 2004; Strong *et al.*, 2005; Taras, 2005; Dishman *et al.*, 2006; Warburton *et al.*, 2006; Hillman *et al.*, 2008; ACSM, 2010; Shephard *et al.*, 2011; Smit *et al.*, 2011; Mujović & Čubrilo, 2012), but also shapes lifelong behaviour in terms of physical activity (Lovell *et al.*, 2010).

2.6. The components of physical fitness

2.6.1. Cardiovascular endurance

2.6.1.1. What is cardiovascular endurance?

One of the most important components of physical fitness is cardiovascular endurance (Heyward, 2006), also referred to as cardio-respiratory endurance (Plowman & Smith, 2014), aerobic power or endurance fitness (US Department of Health and Human Services, 1996). Cardiovascular endurance is a physiological aspect (Lindwall *et al.*, 2012) that involves the ability to carry out dynamic exercise at moderate intensity for prolonged periods at a time. It involves the large muscle groups (Heyward, 2006; Plowman & Smith, 2014). Cardiovascular endurance is largely influenced by age, sex, genetics (Lindwall *et al.*, 2012; Huang *et al.*, 2013), medical status (US Department of Health and Human Services, 1996; Lindwall *et al.*, 2012) and physical activity (Thirlaway & Benton, 1992; Strong *et al.*, 2005; Huang *et al.*, 2013). One should engage in aerobic type exercises (Tuckman & Hinkle, 1986) such as walking, rowing, swimming and stair-climbing (Plowman & Smith, 2014) to improve cardiovascular endurance. Cardiovascular fitness declines with inactivity (Townsend *et al.*, 2012).

Cardiovascular endurance increases cardiac dimensions. It increases the size of blood vessels and blood volume. Cardiovascular endurance is associated with a lower resting heart rate, which is indicative of a healthy heart (MacAuley, 2007; Plowman & Smith, 2014). Cardiovascular endurance has been positively associated with improvements in cognitive abilities (Etnier *et al.*, 1997; Colcombe *et al.*, 2003; Colcombe & Kramer, 2003) and academic performance (McAuley *et al.*, 1994; Dwyer

et al., 2001; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Eveland-Sayers *et al.*, 2009; Welk *et al.*, 2010; Van Dusen *et al.*, 2011). Studies have shown that when field tests are used to assess cardiovascular fitness, the latter was strongly associated with academic performance (Dwyer *et al.*, 2001; Castelli *et al.*, 2007; Eveland-Sayers *et al.*, 2009). Cottrell *et al.* (2007) found that children who had low aerobic fitness levels also had lower academic scores than those with higher aerobic fitness scores.

2.6.1.2. How is cardiovascular endurance measured?

Cardiovascular endurance can be measured maximally or sub-maximally (Etnier *et al.*, 2006) using a variety of protocols (Fox *et al.*, 1993; Heyward, 2006). Maximal oxygen uptake, known as aerobic power or maximal oxygen uptake ($\text{VO}_2 \text{ max}$) is the best criterion of cardio-respiratory fitness and is measured during dynamic activity using the large muscles. Examples include walking or cycling. Maximal tests are relatively expensive, they require time and highly trained technicians, and tend to place a burden on the participant and the examiner. Submaximal tests have therefore been developed. When using sub-maximal protocols, oxygen uptake (VO_2) is predicted using the heart rate response to a determined workload (US Department of Health and Human Services, 1996). When assessing cardiovascular endurance in the laboratory, one can make use of the treadmill, the cycle ergometer or a step bench (Heyward, 2006). Field tests are the preferred method for measuring cardiovascular endurance in large groups as these tests are inexpensive, practical and less time consuming. Examples of field tests include the 1,5 mile run/walk test (Heyward, 2006; Plowman & Smith, 2014) and the 9 or 12 minute run test (Heyward, 2006). Both are valid tests for measuring cardiovascular endurance (Baechle & Earle, 2008). Another valid measure is the progressive aerobic cardiovascular endurance run. This is a 20 metre shuttle run that increases progressively in difficulty level (Castelli *et al.*, 2007). One can also make use of the one mile jogging test, the 12 minute cycling test, or step tests. The advantage of step tests is that highly trained personnel are not required. Accurate measurements of pulse rate will determine the validity of step tests (Heyward, 2006).

When examining the relationship between physical fitness and academic achievement, studies have utilised various methods to assess cardiovascular fitness, including the one mile run test (Dwyer *et al.*, 2001; Eveland-Sayers *et al.*, 2009; Welk

et al., 2010; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011; Liao *et al.*, 2013), the 20 mile shuttle run (Castelli *et al.*, 2007; Welk *et al.*, 2010; Van Dusen *et al.*, 2011), and the bicycle ergometer in which the workload increases by 50 watts for males and 40 watts for females (Thirlaway & Benton, 1992; Kwak *et al.*, 2009). A study by Pastula *et al.* (2012) assessed cardiovascular fitness through the Young Men's Christian Association (YMCA) step test. Smit *et al.* (2011) used the YMCA protocol while using the PWC₁₇₀ bicycle test. Kim *et al.* (2003) used a 100 m and 600–1 000 m distance run to measure cardiovascular fitness whereas Liao *et al.* (2013) made used the 1 600 m and 800 m run/walk test for men and women, respectively. Some studies have shown that combining age, sex, BMI and a self-reported scale can be a good indication of cardio-respiratory fitness (Jurca *et al.*, 2005; Mailey *et al.*, 2010).

2.6.2. Body composition

2.6.2.1. What is body composition?

Body composition is a vital component of an individual's health profile and fitness profile (Heyward, 2006). Body composition is the partitioning of body mass into fat mass and fat-free mass (Heyward, 2006; Baechle & Earle, 2008; Plowman & Smith, 2014). In order to classify body type, one can utilise somatotyping. Sheldon classified the human body into three categories, namely endomorphy, mesomorphy, and ectomorphy. Each person contains all three components. Endomorphy refers to the “fatness” component and is characterised by a round, soft body. Mesomorphy is characterised by hard and prominent musculature. This body type is generally square shaped with large bones and thick muscles. Ectomorphy, also known as the “lean” component, refers to lean, delicate body shapes. These body shapes are characterised by small bones and thin muscles (Fox *et al.*, 1993).

Aerobic exercise reduces body fat (Tuckman & Hinkle, 1986) and improves overall body composition (Warburton *et al.*, 2006). A study by Dwyer *et al.* (1983) showed that participation in physical fitness programmes that emphasise endurance, decreased the percentage of body fat. Body composition is also positively influenced by muscle fitness (Plowman & Smith, 2014). An Australian study demonstrated that increasing the physical activity levels of Grade 5 learners to 75 minutes per day resulted in a decrease in skinfold measurements and an increase in cardiovascular

endurance. They put the emphasis on increasing the learners' heart rates (Shephard, 1997).

Individuals who are overweight or underweight tend to become ill more often than individuals of normal weight (Palmore, 1970). Maintaining a normal body composition reduces the risk of developing NCD such as heart attack, stroke and various cancers (Hajian-Tilaki & Heidari, 2006; Bradshaw *et al.*, 2011). While endo-mesomorphs have a higher risk of developing coronary artery disease (Fox *et al.*, 1993), maintaining a normal body composition reduces the risk of morbidity and mortality (Stevens *et al.*, 2002).

2.6.2.2. How is body composition measured?

Various methods can be used to determine an individual's body composition. Magnetic resonance imaging, total body electrical conduction and computed tomography are expensive methods that can be used for this purpose. Hydrostatic weighing, bioelectrical impedance analysis and anthropometric skinfold measurements are popular, reliable and accessible methods (Fox *et al.*, 1993; Heyward, 2006; MacAuley, 2007; Baechle & Earle, 2008; Plowman & Smith, 2014). When measuring body composition by means of bioelectrical impedance analysis, one places an electrode on the right wrist and the right ankle. A portable device is used to measure the body's electrical resistance to a current passing through the body. Hydrostatic weighing provides an accurate measurement of body composition (Fox *et al.*, 1993; Heyward, 2006; MacAuley, 2007; Mujović & Čubrilo, 2012). It is based on the Archimedes principle that states that when an object is immersed in water, it is buoyed by a "force" that equals the amount of water displaced (Fox *et al.*, 1993; Plowman & Smith, 2014). Skinfold measurements are also an accurate measure of body fat (MacAuley, 2007; Baechle & Earle, 2008; Mujović & Čubrilo, 2012) and are the most widely used method for measuring body composition (Fox *et al.*, 1993). Anthropometric measurements are widely used as they are practical, reasonably accurate, and require minimal equipment (Heyward, 2006; Plowman & Smith, 2014). The validity of anthropometric measurements is affected by the technician's skill, client factors and the equipment (Heyward, 2006). Skinfold measurements measure the thickness of subcutaneous adipose tissue indirectly (Heyward, 2006). When using the anthropometric method, measurements of stature,

body weight, skinfold (bicep, tricep, subscapular, supra-iliac, and the medial part of the mid-calf), two circumference measurements (flexed upper arm and the calf), and two bone width measurements (humerus and the femur) are used (Fox *et al.*, 1993; Heyward, 2006; Plowman & Smith, 2014).

According to Sheldon's somatotype method, one would be required to take a photograph of the individual standing in all three planes. A number of measurements would be taken from the three photographs and the somatotype would be determined in accordance with tables developed by Sheldon. The degree of each component is represented by a number from 1 to 7 with 1 representing the smallest amount of the component and 7 the greatest amount of the component. For example, a somatotype of 7-1-1 indicates extreme endomorphy whereas a somatotype of 1-1-7 represents extreme ectomorphy. Extreme mesomorphy would be represented as 1-7-1 (Fox *et al.*, 1993).

When assessing the relationship between physical fitness and academic performance many studies used skinfold measurements to assess body composition (Thirlaway & Benton, 1992; Dwyer *et al.*, 2001; Kwak *et al.*, 2009; Du Toit *et al.*, 2011) while others used only BMI (Tremblay *et al.*, 2000; Kim *et al.*, 2003; Coe *et al.*, 2006; Castelli *et al.*, 2007; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Ruiz *et al.*, 2010; Welk *et al.*, 2010). To calculate BMI, weight (in kilograms) is divided by height squared (in metres) (Palmore, 1970; US Department of Health and Human Services, 1996; Mokdad *et al.*, 2004; Heyward, 2006; MacAuley, 2007; Bradshaw *et al.*, 2011; Plowman & Smith, 2014).

2.6.3. Muscle strength

2.6.3.1. What is muscle strength?

Muscle strength refers to the force or tension that a muscle, or a muscle group, is able to exert in one maximal contraction against a resistance (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008; Plowman & Smith, 2014). Isometric, isotonic, eccentric and isokinetic contractions are the four basic types of muscle contraction (Fox *et al.*, 1993; US Department of Health and Human Services, 1996; Heyward, 2006; Plowman & Smith, 2014). Isometric contraction, also referred to as static contraction, occurs when the muscle develops tension but there is no change

in muscle length (Fox *et al.*, 1993; US Department of Health and Human Services, 1996; Heyward, 2006; Plowman & Smith, 2014). The muscle pulls against external resistance that is greater than the internal force generated by the muscle (Fox *et al.*, 1993; Heyward, 2006; Plowman & Smith, 2014). Isotonic contraction, also known as dynamic or concentric contraction, refers to a muscle shortening while lifting a fixed load. The speed of movement may be relatively slow and not controlled. Eccentric contraction is defined as a muscle lengthening during a contraction. Isokinetic contraction refers to the maximal tension developed by a muscle, at all joint angles, over the full range of motion as it shortens at a constant speed (Fox *et al.*, 1993; Heyward, 2006; Plowman & Smith, 2014). Physical activity (Strong *et al.*, 2005; Mujović & Čubrilo, 2012), specifically resistance training (Plowman & Smith, 2014) increases muscle strength.

Muscle strength is associated with an improvement in overall health, and a reduction in disability and mortality (Plowman & Smith, 2014). When assessing the link between muscle strength and academic performance, Castelli *et al.* (2007) observed no link whereas Dwyer *et al.* (2001) and Van Dusen *et al.* (2011) reported a positive association between the two. Du Toit *et al.* (2011) noticed a positive association between specific strength test measures and academic achievement.

2.6.3.2. How is muscle strength measured?

Muscle strength can be measured during a static or a dynamic muscle contraction (US Department of Health and Human Services, 1996; MacAuley, 2007). The one repetition maximum bench press and the one repetition maximum back squat are commonly used to measure muscle strength (Baechle & Earle, 2008). Isometric dynamometers can also be used to measure muscle strength (Heyward, 2006). The advantage of isometric tests is that they are inexpensive and easily standardised (MacAuley, 2007). When assessing the relationship between physical fitness and academic performance, studies have utilised the following protocols when measuring muscle strength: the trunk lift test (Grissom, 2005; Van Dusen *et al.*, 2011), the hand grip dynamometry when measuring hand grip strength, the push-pull dynamometer when measuring shoulder flexion and extension, and the back and leg dynamometer when measuring leg force (Dwyer *et al.*, 2001). Du Toit *et al.* (2011) utilised five strength tests, namely the standing long-jump test, bent leg sit-ups, knee push-ups,

aeroplane lying, and wall sitting tests. Liao *et al.* (2013) utilised the long-jump test to assess muscle strength.

2.6.4. Muscle endurance

2.6.4.1. What is muscle endurance?

Muscle endurance is defined as the ability of the muscle or muscle group to perform repeated contractions against a light load for an extended period of time. Local muscle endurance refers to the ability of a muscle group to execute repeated isotonic, isokinetic or eccentric contractions against a load, or to sustain an isometric contraction for an extended period of time. Muscles with a low endurance capacity fatigue quicker than muscles with a high endurance capacity (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008).

Muscle endurance is improved through physical activity (Strong *et al.*, 2005; Mujović & Čubrilo, 2012) and is positively associated with mobility, bone health and functional independence (Warburton *et al.*, 2006). Higher levels of muscle fitness reduce the risk of lower back pain (Heyward, 2006; Plowman & Smith, 2014), musculoskeletal injuries and osteoporotic fractures (Heyward, 2006). It decreases the risk of falls, illness (Warburton *et al.*, 2006), chronic disease (Plowman & Smith, 2014) and premature death (Warburton *et al.*, 2006; Plowman & Smith, 2014). Muscle fitness has a positive effect on metabolic health and cardiovascular risk factors (Plowman & Smith, 2014), and improves psychological well-being and overall quality of life (Warburton *et al.*, 2006). Although some studies have reported a positive association between academic test scores and muscle fitness (Dwyer *et al.*, 2001; Eveland-Sayers *et al.*, 2009), Castelli *et al.* (2007) observed no such association.

2.6.4.2. How is muscle endurance measured?

Performing the maximal number of repetitions of parallel bar dips, push-ups or chin ups are examples of testing local muscle endurance (Baechle & Earle, 2008). The sit-up test (US Department of Health and Human Services, 1996; Plowman & Smith, 2014), curl-up test (Heyward, 2006; Baechle & Earle, 2008; Plowman & Smith, 2014), and YMCA bench press test are commonly used to measure muscle endurance (Heyward, 2006; Baechle & Earle, 2008). When comparing academic

success with physical fitness the curl-up test has been a reliable measure for muscle endurance (Grissom, 2005; Castelli *et al.*, 2007; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Van Dusen *et al.*, 2011; Liao *et al.*, 2013). Eveland-Sayers *et al.* (2009) utilised push-ups and curl-ups to assess muscle endurance and Dwyer *et al.* (2001) utilised the sit-up test.

2.6.5. Flexibility

2.6.5.1. What is flexibility?

Flexibility is an important component of muscle performance (Fox *et al.*, 1993) and refers to the range of movement of a joint or the range of movement of a group of joints (Heyward, 2006; MacAuley, 2007; Baechle & Earle, 2008; Plowman & Smith, 2014). Age, gender, body type and physical activity levels are factors that may influence flexibility (Heyward, 2006). Flexibility is specific to each joint, which implies that being flexible in one joint does not indicate high flexibility in another joint (Arnheim & Prentice, 1993; Fox *et al.*, 1993; US Department of Health and Human Services, 1996; Baechle & Earle, 2008).

Flexibility is divided into static and dynamic flexibility (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008; Plowman & Smith, 2014). Static flexibility is defined as the range of motion around a joint whereas dynamic flexibility refers to the resistance of a joint to movement (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008). When a joint moves beyond its normal range of motion it is referred to as hyperflexibility. Hyperflexibility should be avoided as it increases the chance of dislocations and subluxations (Arnheim & Prentice, 1993; Baechle & Earle, 2008). Resistance to stretch is known as stiffness (Plowman & Smith, 2014).

Flexibility is necessary for correct posture and muscle relaxation and in daily living (Plowman & Smith, 2014). It plays an important role when performing certain skills (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008). Being flexible allows the body to move more freely and easily, and reduces the risk of injury (Baechle & Earle, 2008). Research has indicated that flexibility exercises lead to a wide range of chemical and neural adaptations in the brain. This increases people's ability to think critically (Kramer *et al.*, 2006). Castelli *et al.* (2007) noted that no association was seen between flexibility and academic scores. Van Dusen *et al.* (2011) and Liao *et*

al. (2013) reported a positive association between physical fitness and academic scores.

Flexibility can be improved through physical activity (Mujović & Čubrilo, 2012) and daily stretching (Arnheim & Prentice, 1993; Fox *et al.*, 1993; Heyward, 2006). Limitations to flexibility include the size and the strength of muscles, connective tissue and the ligaments (Heyward, 2006). Bone, muscle, ligaments, tendons and skin are structural limitations to flexibility (Fox *et al.*, 1993; Heyward, 2006; Baechle & Earle, 2008). The assumption is that if someone develops bulk through strength training it will affect their flexibility negatively. It is thought that bulky people lose their ability to move freely owing to the size of their muscles. If trained properly, strength training should not impair flexibility (Arnheim & Prentice, 1993).

2.6.5.2. How is flexibility measured?

Flexibility can be measured using laboratory tests as well as field tests (Heyward, 2006; Plowman & Smith, 2014). The most popular field tests used to measure flexibility is the sit-and-reach test (Plowman & Smith, 2014). It involves an indirect, linear measurement of range of motion (Heyward, 2006) measuring lower back and hamstring flexibility (US Department of Health and Human Services, 1996; Baechle & Earle, 2008; Plowman & Smith, 2014). Studies have shown that the sit-and-reach test is a valid measure of hamstring flexibility (Plowman & Smith, 2014). A flexometer, goniometer and an inclinometer can also be used to measure flexibility (Heyward, 2006). When comparing the relationship between physical fitness and academic performance many studies used the sit-and-reach test to measure flexibility (Castelli *et al.*, 2007; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011; Liao *et al.*, 2013).

2.7. The relationship between physical fitness and academic performance

The relationship between physical fitness and mental fitness dates back several decades (Colcombe & Kramer, 2003). Owing to the pressure on students to perform academically (Coe *et al.*, 2006), coupled with the increase in obesity, the public have focused their attention on physical activity and diet in the academic environment (Chomitz *et al.*, 2009; Rodenroth, 2010). A body of literature researched the effects

of physical activity and physical fitness on academic performance (Dwyer *et al.*, 1983; Keays & Allison, 1995; Shephard, 1997; Sallis *et al.*, 1999; Tremblay *et al.*, 2000; Dwyer *et al.*, 2001; Kim *et al.*, 2003; Grissom, 2005; Coe *et al.*, 2006; Nelson & Gordon-Larsen, 2006; Burton & Van Heest, 2007; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Tomporowski *et al.*, 2008; Trudeau & Shephard, 2008; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Kwak *et al.*, 2009; Welk *et al.*, 2010; Zoeller, 2010; Du Toit *et al.*, 2011; Shephard *et al.*, 2011; Van Dusen *et al.*, 2011; Al-Nader *et al.*, 2013; Liao *et al.*, 2013). The majority of studies indicated a positive relationship between levels of physical activity, physical fitness and academic achievement (Keays & Allison, 1995; Shephard, 1997; Dwyer *et al.*, 2001; Grissom, 2005; Coe *et al.*, 2006; Nelson & Gordon-Larsen, 2006; Burton & Van Heest, 2007; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Trudeau & Shephard, 2008; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Kwak *et al.*, 2009; Welk *et al.*, 2010; Zoeller, 2010; Du Toit *et al.*, 2011; Shephard *et al.*, 2011; Van Dusen *et al.*, 2011; Al-Nader *et al.*, 2013; Liao *et al.*, 2013).

Quasi-experimental studies (Trudeau & Shephard, 2008) and cross-sectional studies indicated a positive association between physical fitness and academic achievement (Shephard, 1997; Tremblay *et al.*, 2000; Dwyer *et al.*, 2001). In fact, replacing instructional class time with physical activity has been shown not to impair academic performance (Dwyer *et al.*, 1983; Shephard, 1983; Shephard, 1997; Sallis *et al.*, 1999; Grissom, 2005; Coe *et al.*, 2006; Ahamed *et al.*, 2007; Trudeau & Shephard, 2008; Keeley & Fox, 2009; Trost & van der Mars, 2010). Evidence indicates that students receiving additional physical education perform as well or even better than students who do not receive extra physical education (Shephard, 1997; Almond & McGeorge, 1998). Allocating 14–26% of physical activity to the curriculum seems to speed up the rate of learning per unit of classroom time (Shephard, 1997). A study by Coe *et al.* (2006) reported that students who spent 55 minutes less in the classroom and participated in physical education instead did not perform worse academically. They performed equally well in science, English, and mathematics compared to the group who were allocated 55 minutes of arts and computer science per day.

Shephard (1997) and Tremblay *et al.* (2000) discussed the findings from two longitudinal studies conducted in France and Canada. The study in France took place in the 1950s and utilised an intervention. Students in the experimental group participated in physical activity every afternoon and received vitamin supplements. The time they devoted to academic instruction was reduced by 26%, but their school day was lengthened so that they were able to participate in physical activity. The study concluded that academic achievement was not negatively influenced by replacing instructional class time with physical activity. Teachers from the experimental school indicated that the learners in their school showed less disruptive behaviour, better attendance, and appeared calmer and more attentive during class. Vitamin supplements and daily naps were included in the programme, confounding the effect of the physical education intervention. The quasi-experimental Canadian study was conducted between 1970 and 1977 in the Trois Rivières region. It came to the conclusion that replacing educational class time with physical education did not have a negative influence on students' academic achievement. The experimental group consisted of 546 children who had a 14% reduction in academic instructional time, and one hour extra of physical activity. Initially the control group performed better academically, but over the six year period the experimental group outperformed the control group in grades 2, 3, 5 and 6. Children who received physical education scored higher in mathematics despite the fact that 33 minutes of mathematics instruction time had been taken away. The improvements were higher for girls than for boys. Overall results indicated that there were improvements in fitness scores, psychomotor abilities and academic scores (Shephard, 1983; Shephard, 1997).

Liao *et al.* (2013) examined the relationship between physical fitness and academic performance across a three year spectrum, and concluded that overall physical fitness was related to scores in the Taiwan university entrance exam. Coe *et al.* (2006) indicated that level of physical activity is important when examining the relationship between physical fitness and academic performance. It was shown that physical activity performed vigorously had a positive effect on academic achievement. Kwak *et al.* (2009) reported that the only intensity level significantly associated with academic achievement in girls was a vigorous level of physical activity. These results correlated with the findings of Coe *et al.* (2006) which

suggested that a physical activity intensity “threshold” is needed to positively influence academic performance. Taras (2005) reviewed 14 studies and noticed that there was only a weak but significant association between physical activity and academic performance, and in some instances no correlation was observed. Yu *et al.* (2006) observed no association between physical activity and academic achievement in an analysis of Hong Kong pre-adolescent boys.

It is difficult however to draw conclusions as to whether or not fitness has a positive effect on academic performance, because many studies lack control for confounding variables. Past research often failed to adequately control for confounding factors such as mental health status (Eveland-Sayers *et al.*, 2009) and SES (Coe *et al.*, 2006; Eveland-Sayers *et al.*, 2009; Welk *et al.*, 2010), and have been limited by the use of non-standardised academic tests and fitness tests (Welk *et al.*, 2010). Another limitation in many studies is that they rely on self-reported data of physical activity and academic performance. This complicates matters when drawing an overall conclusion (Sigfusdottir *et al.*, 2007).

Many studies have shown that there is a stronger association between fitness and academic performance in girls than in boys (Grissom, 2005; Carlson *et al.*, 2008; Eveland-Sayers *et al.*, 2009; Kwak *et al.*, 2009; Welk *et al.*, 2010; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011). No research has shown a stronger relationship between physical fitness and academic performance in boys than in girls. Girls have been shown to have lower self-esteem than boys during childhood and adolescence. It is perhaps for this reason that participation in sport may play a more significant role in girls than in boys (Quatman & Watson, 2001; Eveland-Sayers *et al.*, 2009; Welk *et al.*, 2010). A study by Fountaine *et al.* (2011) indicated that male students spend more time watching television than female students who spend more time doing homework. This could be an additional reason for the stronger association in girls than in boys.

2.7.1. Physiological mechanisms for explaining the positive association between physical fitness and academic performance

In addition to psychological mechanisms, there are physiological mechanisms that can explain the positive association between physical fitness, cognitive functioning

and academic performance (Kwak *et al.*, 2009). Physiological mechanisms refer to the stimulation of brain growth factors through physical activity (Dishman *et al.*, 2006). This includes an increase in BDNF (Neeper *et al.*, 1996; Cotman & Berchtold, 2002), an increase in nerve growth factor (Neeper *et al.*, 1996) and an increase in blood flow to the brain cortex (Herholz *et al.*, 1987; Shephard, 1997; Cotman & Berchtold, 2002; Barnes *et al.*, 2003; Taras, 2005; Lambourne, 2006; Hall, 2007; Pereira *et al.*, 2007; Hillman *et al.*, 2008; Trudeau & Shephard, 2008; Eveland-Sayers *et al.*, 2009; Du Toit *et al.*, 2011). An increase in cerebral blood flow leads to an increase in nutrients, such as glucose and oxygen, used by the brain for energy (Hall, 2007). This helps with cognitive reasoning and functioning (Woodward, 2009). Research shows that a reduction in cerebral blood flow leads to a reduction in cognitive function (Barnes *et al.*, 2003).

The increase in the levels of brain growth factors leads to an improvement of neurogenesis in the dentate gyrus of the hippocampus (Neeper *et al.*, 1996; Van Praag *et al.*, 1999; Cotman & Berchtold, 2002; Kramer *et al.*, 2006) and angiogenesis (Churchill *et al.*, 2002; Cotman & Berchtold, 2002; Kramer *et al.*, 2006). Neurogenesis refers to the growth of new nerve cells in the nervous system (Keeley & Fox, 2009) whereas angiogenesis refers to the growth of new capillaries from pre-existing blood vessels (Churchill *et al.*, 2002).

BDNF is part of the neurotrophin family (Wang *et al.*, 1995; Neeper *et al.*, 1996; Siuciak *et al.*, 1996; Shirayama *et al.*, 2002; Huang *et al.*, 2013) and an arbitrator of eating behaviour, metabolic efficiency, learning and memory (Vaynman & Gomez-Pinilla, 2006). BDNF is an important mediator of the benefits of physical activity for brain health (Cotman & Berchtold, 2002; Huang *et al.*, 2013). It enhances cognition by promoting the ability of neurons to interact with each other (Jensen, 1998; Hall, 2007). Having a greater number of neurons enables an individual to retrieve, understand and remember information at a faster rate (Hall, 2007). When BDNF action is blocked in the hippocampus, cognitive functioning is inhibited and learning and memory are impaired (Vaynman & Gomez-Pinilla, 2006). Exercise increases serum BDNF levels (Cotman & Berchtold, 2002; Winter *et al.*, 2007; Lou *et al.*, 2008; Huang *et al.*, 2013), epinephrine, dopamine and serotonin (Winter *et al.*, 2007; Cotman & Berchtold, 2002), allowing the brain to be more adaptive to change

(Colcombe *et al.*, 2003). This results in improved cognitive performance (Winter *et al.*, 2007; Huang *et al.*, 2013) and successful learning (Winter *et al.*, 2007). BDNF also induces neurogenesis in certain areas of the brain during exercise (Russo-Neustadt *et al.*, 2000). Exercise increases mitochondrial uncoupling protein 2 levels in the hippocampus. Mitochondrial uncoupling protein 2 is an energy balancing factor involved in adenosine triphosphate production. It helps to maintain calcium homeostasis (Vaynman & Gomez-Pinilla, 2006), and regulates BDNF production (Dishman *et al.*, 2006).

Aerobic exercise leads to arousal of the sympathetic nervous system, cortical stimulation and metabolic adaptations, which can explain the positive association between physical activity and cognitive functioning (Davis *et al.*, 2007). Physical activity stimulates neural development (Jensen, 1998; Studenski *et al.*, 2006), it leads to a higher capillary volume (Kramer *et al.*, 2002; Studenski *et al.*, 2006), as well as increased density of neuronal synapses (Black *et al.*, 1987; Trudeau & Shephard, 2008; Chomitz *et al.*, 2009). Evidence indicates that brain tissue volume is increased through physical activity, especially when there is an improvement in cardio-respiratory fitness (Cotman & Berchtold, 2002; Colcombe *et al.*, 2006; Kramer *et al.*, 2006). Mortmer *et al.* (2012) concluded that T'ai Chi (a type of moving meditation) increases brain volume and leads to improvements in neuropsychological measurements.

Huang *et al.* (2013) reviewed 32 articles and summarised the effects of physical activity on peripheral BDNF. Experimental studies showed that both acute and sustained aerobic type exercise increased peripheral BDNF levels. An experimental study observed that serum BDNF concentrations increased significantly in healthy male athletes after completing a ramp test to exhaustion, but it failed to change significantly after a ten minute moderate intensity warm-up (Rojas Vega *et al.*, 2006). Erickson *et al.* (2011) reported that a year of aerobic exercise increased serum BDNF levels and spatial memory in the elderly. The majority of the reviewed studies showed that peripheral BDNF was not influenced by resistance training (Huang *et al.*, 2013). Yarrow *et al.* (2010) however, reported that a single bout of resistance training led to a change in serum BDNF levels. Coelho *et al.* (2012) indicated that

three months of strength training significantly increased plasma BDNF levels in elderly women.

Studies of animals have demonstrated that physical and mental exercise affects the brain in a variety of important ways (Kramer *et al.*, 2006). Exercise activates cellular and the molecular cascades responsible for maintaining brain plasticity (Cotman & Berchtold, 2002; Dishman *et al.*, 2006; Huang *et al.*, 2013). Brain plasticity is generally associated with better cognitive functioning (Cotman & Berchtold, 2002). Exercise promotes brain vascularisation (Black *et al.*, 1990; Cotman & Berchtold, 2002) and enhances learning (Shephard, 1997; Jensen, 1998; Van Praag *et al.*, 1999; Dwyer *et al.*, 2001; Chomitz *et al.*, 2009). Studies on animals showed that rats that had been raised in environments that allowed them to play, developed a higher capillary volume per nerve cell and performed better than those that had been raised in less enriched environments. They also developed a higher density of synapses (Kempermann *et al.*, 1997; Jensen, 1998) and a larger number of dendritic spines (Greenough & Black, 1992). The amount of surviving new-born cells found in the dentate gyrus doubled when exposed to enriched environments and voluntary physical activity. This could be owing to the fact that exercise increases serotonin (Cotman & Berchtold, 2002; Winter *et al.*, 2007), which influences adult neurogenesis (Churchill *et al.*, 2002). Van Praag *et al.* (1999) and Van Praag (2008) found that mice that had unrestricted access to a running wheel showed an increase in cell proliferation. Kramer *et al.* (2006) found that wheel running in rodents increases performance in spatial learning tasks. Radák *et al.* (2001) examined the effect of regular swimming on rats and found that regular physical activity improved cognition and altered the accumulation of brain oxidative stress markers. There was a decrease in the accumulation of reactive carbonyl derivatives, which may explain the improvement in learning and memory.

2.8. Summary

While many studies have examined the association between physical fitness and academic performance in children and adolescents, this researcher could not locate any studies that examined the association between physical fitness and academic performance in university students. If this study demonstrates a significant positive correlation between fitness and academic performance, it is recommended that

universities find ways to motivate students to become physically active. University students are more likely to be associated with negative health behaviours (Leslie *et al.*, 2001; Ferrara, 2009; Wengreen & Moncur, 2009; Amponsah & Owolabi, 2011; Fountaine *et al.*, 2011; Varela-Mato *et al.*, 2012), such as a negative change in their eating habits, an increase in alcohol intake (Ferrara, 2009; Varela-Mato *et al.*, 2012), and a decrease in physical activity (Ferrara, 2009; Wengreen & Moncur, 2009; Varela-Mato *et al.*, 2012), all of which can have a negative impact on their academic performance. Their risk of cancer increases owing to the change in health behaviours (Baranowski *et al.*, 1997). A study indicated that conducting a pedometer intervention in the university setting is feasible. Walking 10 000 steps a day in an unsupervised walking programme showed a significant increase in physical activity in sedentary students. It was suggested that a pedometer intervention could be suitable early in their university careers (Tully & Cupples, 2011). Walking with fellow students during lunch is one strategy to make exercise adherence part of one's daily routine (Buckworth, 2001).



CHAPTER 3: METHODOLOGY

The methods and procedures followed in this study will be discussed below.

3.1. Research approach and study design

In a descriptive correlational study design, the researcher strives to determine and describe the association that exists between variables (Thomas *et al.*, 2011). This research is referred to as a descriptive correlational study because the researcher examined the relationship between certain traits, such as cardiovascular endurance, muscle endurance, muscle strength, flexibility, body composition and health status, on academic performance. A correlational study design is descriptive. One cannot presume there will be a cause-and-effect relationship (Thomas & Nelson, 2001; Thomas *et al.*, 2011). Correlational research involves no administration of experimental treatments and no manipulation of variables (Thomas *et al.*, 2011). By the end of the study, the researcher was able to determine whether an association exists between two or more traits (Thomas & Nelson, 2001; Thomas *et al.*, 2011).

3.2. Research procedure and strategy

The research procedure and strategy followed in this study are outlined in chronological order below:

- The proposal and testing procedures for the study were finalised.
- Approval was obtained from the University of Pretoria's Humanities Postgraduate Committee.
- Approval was obtained from the Faculty of Humanities' Ethics Committee at the University of Pretoria to conduct the study.
- Permission was obtained to use the testing facilities at the L.C. de Villiers Sports Grounds.
- Participants were recruited by word of mouth.
- Each participant signed an informed consent (Appendix A), indemnity (Appendix B) and Par-Q form (Appendix C) before participating in the study.

- Each participant completed a Belloc and Breslow Lifestyle Questionnaire (Appendix D) (detail given in Section 3.8).
- Participants were tested on three separate occasions through the year (detail given in Section 3.8). The first test took place at the end of January 2014, the second test took place at the end of May 2014, and the third test at the end of October 2014. The following components of physical fitness were measured:
 - body composition;
 - muscle strength;
 - flexibility;
 - cardiovascular endurance; and
 - muscle endurance.
- On completion of the last test in October, participants were given feedback on their health status (Appendix E).
- The researcher used the students' university academic average in analysing the data.
- The AP score was obtained from their matric certificates.

3.3. Ethical approval and considerations

Prior to testing, the research protocol was submitted and approved by the Post-Graduate Research Committee and the Ethics Committee of the Faculty of Humanities at the University of Pretoria (reference no. 01295004). Participants were only included in the study once they had given written, informed consent (Appendix A). The researcher explained the exact nature of the study to the participants before testing. For identification purposes each participant's name was used (Sperry *et al.*, 1991). Data will be stored for 15 years in the Department of Sport and Leisure Studies.

3.4. Setting

Testing took place in a controlled environment in laboratories at the Institute for Sports Research. Two researchers who are qualified biokineticists were present to carry out the tests.

3.5. Participant selection and sample size

A group of 99 university students from the faculties of Humanities were included in the study. The following inclusion and exclusion criteria were followed:

➤ **Inclusion criteria:**

- Both males and females
- First year Baccalaureus Artium (Human Movement Science) (BA (HMS)) students or first year Baccalaureus Artium (Sport Science) (B (SportSci)) students

➤ **Exclusion criteria:**

- Students with mental illness
- Students with physical disabilities

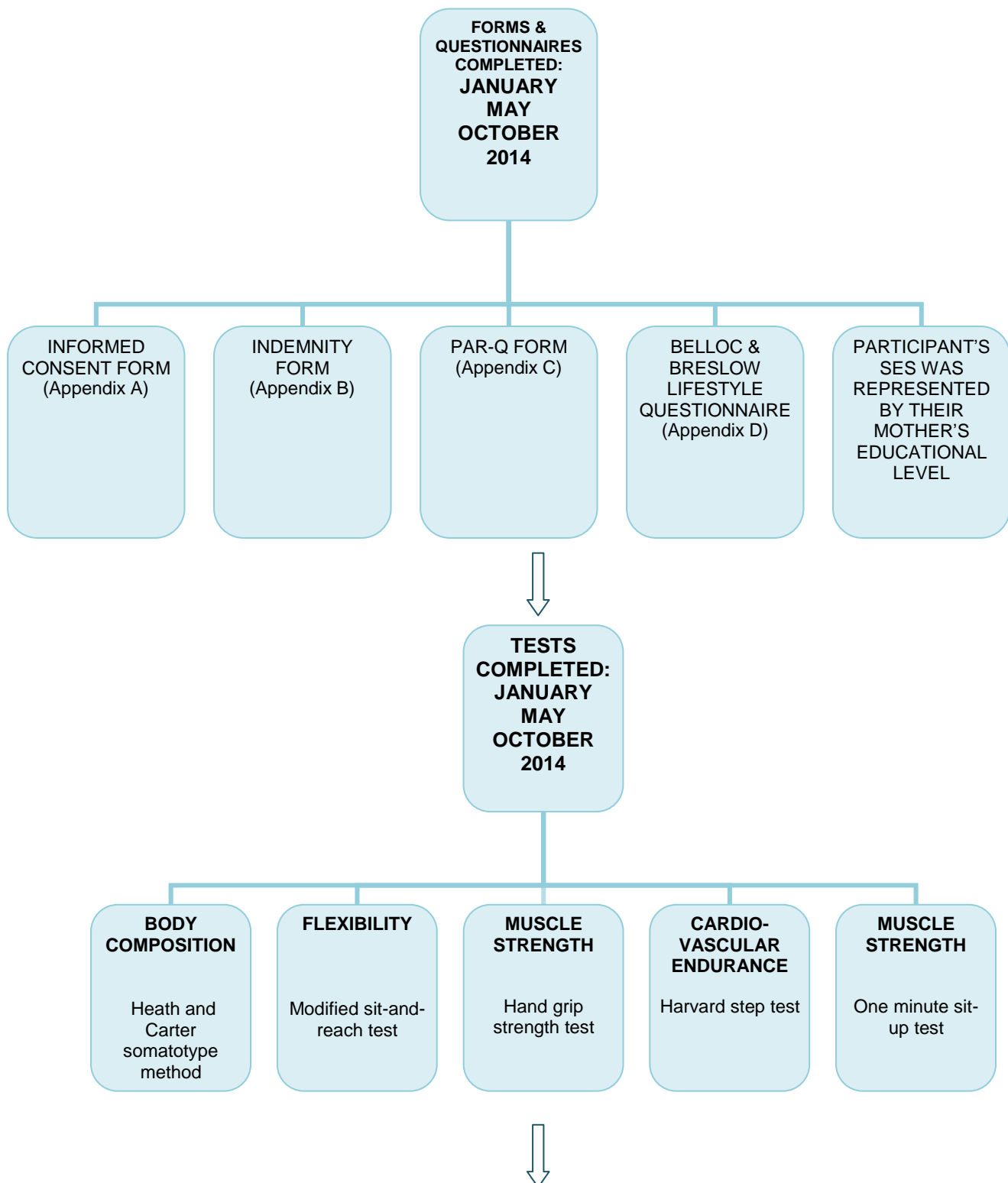
3.6. Pre-test screening

Each participant was thoroughly informed about the purpose, procedures, benefits and risks associated with the study. Participants were given the opportunity to ask questions which were answered by the researcher. Prior to testing, participants completed and signed an informed consent form (Appendix A), indemnity form (Appendix B) and a Par-Q form (Appendix C). All the abovementioned forms were also signed by the study participant, researcher and a witness.

3.7. Test session

Figure 3.1 illustrates the flow of testing and data captured. After completing the informed consent form, indemnity form and Par-Q form, each participant filled in a Belloc and Breslow Lifestyle Questionnaire (Appendix D). This was used to determine the health status of the participant. Each participant indicated their mother's highest level of education. This was used as an indicator of the participant's SES (Kim *et al.*, 2003; Chomitz *et al.*, 2009; Kwak *et al.*, 2009). Each participant was tested by the same tester to improve the internal validity of results. Participants were instructed not to exercise on the day of testing and refrain from consuming alcohol or coffee, smoking and eating three hours prior to testing (Tachmes *et al.*, 1978, Khan

et al., 2011). The procedures and measurements are discussed in detail in Section 3.8.



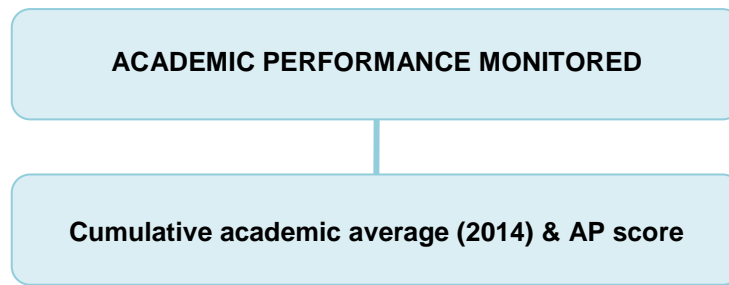


Figure 3.1: Data captured during test sessions

3.8. Procedures

3.8.1. Belloc and Breslow Lifestyle Questionnaire

Participants completed the Belloc and Breslow Lifestyle Questionnaire (Appendix D). Belloc and Breslow (1972) identified the following seven aspects that contribute to a healthy lifestyle, namely:

- *Three meals per day with no eating in-between.* In-between eating adds more food to be digested by the body in a 24 hour cycle. This makes it more difficult for the body to break down all the food consumed.
- *Eating breakfast.* Breakfast starts the metabolism and is considered the most important meal of the day. The later the metabolism starts, the less food will be digested and broken down in the body.
- *Participation in moderate activity two to three times per week.* Participating in moderate activity helps keep the heart strong and keeps it working at a regular pace.
- *No smoking.* Cigarettes contain tar, which has been associated with an increased risk of developing disease, including certain types of cancers.
- *Little/no alcohol intake.* Alcohol is a carbohydrate that inhibits the breakdown of fat in the body. This in turn can increase the fat stored and accumulated in the body.
- *Enough sleep (seven to eight hours).* Getting enough sleep helps the body to recharge.
- *Maintaining a healthy weight.* By maintaining a healthy weight the individual avoids becoming overweight or obese – both conditions associated with various diseases.

The lifestyle habits above are rated according to the number of habits the individual adheres to:

- Three or fewer than three lifestyle habits = poor health lifestyle;
- Four to five lifestyle habits = moderately healthy lifestyle; and
- Six to seven lifestyle habits = healthy lifestyle.

The lifestyle questionnaire included the level of education achieved by the student's mother as an indicator of SES.

3.8.2. Anthropometric measurements

Procedures for the following anthropometric sites were measured by a trained researcher, as prescribed by the International Society for the Advancement of Kinanthropometry. The procedures for the measurements are taken from the textbook, *International standard for anthropometric assessment* (Marfell-Jones *et al.*, 2006). The following anthropometric measurements were conducted and are explained in detail under section 3.8.2.1. to 3.8.2.5.:

- Standing height (cm);
- Body mass (kg);
- Tricep skinfold (mm);
- Subscapular skinfold (mm);
- Bicep skinfold (mm);
- Supra-iliac skinfold (mm);
- Medial calf skinfold (mm);
- Calf circumference (cm);
- Contracted arm circumference (cm);
- Waist circumference (cm);
- Hip circumference (cm);
- Humerus diameter (mm); and
- Femur diameter (mm).

Body composition was assessed using the Heath and Carter somatotype method (Krüger & Van Vuuren, 1998). The Harpenden skinfold calliper was used to take skinfold measurements (Marfell-Jones *et al.*, 2006). Measurements were taken on the right side of the body (Marfell-Jones *et al.*, 2006, ACSM, 2010). To ensure maximum reliability and validity skinfold measurements were taken on dry skin. The

thumb and index finger of the left hand grasped the skin firmly, forming a fold of skin and subcutaneous fat (Marfell-Jones *et al.*, 2006, Baechle & Earle, 2008). Two measurements were taken at each site and were re-tested if not within 1 to 2 mm of each other (Heyward, 2006, Marfell-Jones *et al.*, 2006). The following skinfold sites were measured using a skinfold calliper: triceps, subscapular, biceps, supra-iliac, and medial calf (Eston & Reilly, 1996, Marfell-Jones *et al.*, 2006). Calf, tensed arm, waist and hip circumference measurements were taken by means of an inelastic and flexible tape measure (ACSM, 2010) with the subject standing in a relaxed anatomical position (Baechle & Earle, 2008). The subcutaneous adipose tissue was not compressed. If two duplicate measurements were not within 5 mm of each other, a third measurement was taken (ACSM, 2010). The bi-epicondylar humerus and bi-epicondylar femur were measured using a small spreading calliper (Marfell-Jones *et al.*, 2006).

3.8.2.1. Standing height

Equipment: Stadiometer



Figure 3.2: Standing height measured with a stadiometer

Procedure: Standing height refers to the distance between the feet and the vertex (Marfell-Jones *et al.*, 2006). The participant wore light-weight clothing and no shoes while the measurement was taken (Baechle & Earle, 2008; Mendonca *et al.*, 2011).

The participant stood with his/her heels, buttocks and upper back touching the stadiometer. The heels were together, and the head was in the Frankfurt plane (orbital and the trignon in the same horizontal plane). When the participant was instructed to inhale, the recorder lowered the head board firmly on the vertex. The measurement was recorded before the subject exhaled (Marfell-Jones *et al.*, 2006). Standing height was measured to the nearest 0,1 cm with a stadiometer (Leicester Height Measure, Seca, Birmingham, UK) (see Figure 3.2).

3.8.2.2. Body mass

Equipment: Seca electronic scale

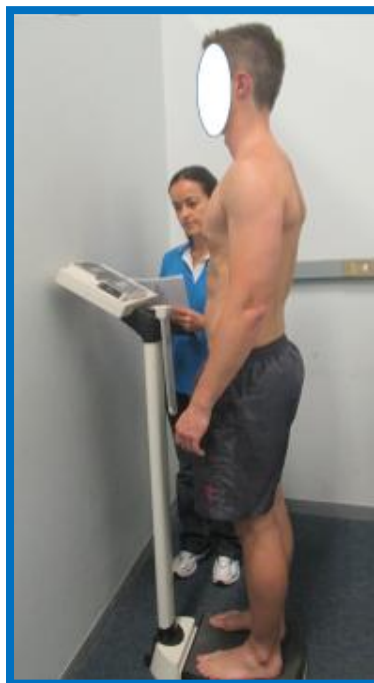


Figure 3.3: Measuring body mass on the electronic scale

Procedure: Body mass was measured using an electronic scale (Seca 703 electronic scale, Delta Surgical South Africa (Pty) Ltd). The participant wore light-weight clothing and no shoes (Baechle & Earle, 2008; Mendonca *et al.*, 2011). The participant stood on the centre of the scale with his/her feet distributed evenly (Marfell-Jones *et al.*, 2006). Mass was measured to the nearest 0,1 kg (see Figure 3.3).

i. Fat percentage classification

According to Acevedo and Starks (2003) and Hoffman (2006), fat percentage was rated as given in Table 3.1.

Table 3.1: Fat percentage norms

Percentile	Rating	Males	Females
90	Excellent	7,1	14,5
80		9,4	17,1
70	Good	11,8	19
60		14,1	20,6
50	Average	15,9	22,1
40		17,4	23,7
30	Poor	19,5	25,4
20		22,4	27,7
10	Extremely bad	25,9	32,1

(Acevedo & Starks, 2003; Hoffman, 2006)

ii. Body mass index (BMI)

BMI indicates whether a person is underweight, of a healthy weight, overweight or obese. It is a measure of a person's body surface area (ACSM, 2006) and is calculated as mass in kilograms (kg) divided by height in metres (m) squared (Mendonca *et al.*, 2011).

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

Classification of BMI

According to the American College of Sports Medicine (ACSM) (2006), BMI ($\text{kg} \cdot \text{m}^{-2}$) is rated as follows:

- Underweight: $< 18,5 \text{ kg} \cdot \text{m}^{-2}$
- Normal: $18,5\text{--}24,9 \text{ kg} \cdot \text{m}^{-2}$
- Overweight: $25,0\text{--}29,9 \text{ kg} \cdot \text{m}^{-2}$
- Obese – Class 1: $30,0\text{--}34,9 \text{ kg} \cdot \text{m}^{-2}$
- Obese – Class 2: $35,0\text{--}39,9 \text{ kg} \cdot \text{m}^{-2}$
- Obese – Class 3: $> 40,0 \text{ kg} \cdot \text{m}^{-2}$

3.8.2.3. Skinfold measurements

The tricep, subscapular, bicep, supra-iliac and medial calf skinfold sites were measured using the Harpenden skinfold calliper (Model HSB-BI, Baty International, West Sussex, RH15 9LR, England) (Marfell-Jones *et al.*, 2006) (see Figure 3.4).



Figure 3.4: Harpenden skinfold calliper

i. Tricep skinfold measurement



Figure 3.5: Tricep skinfold measured using a skinfold calliper

Procedure: The participant stood upright in the neutral position, with the right arm relaxed. The measurement was taken between the acromion and the radial, parallel to the long axis of the arm (Marfell-Jones *et al.*, 2006) (see Figure 3.5).

ii. **Subscapular skinfold**



Figure 3.6: Subscapular skinfold measured using a skinfold calliper

Procedure: The skinfold measurement was taken with the fold running laterally and obliquely downwards at an angle of 45 degrees (Marfell-Jones *et al.*, 2006) (see Figure 3.6).

iii. **Bicep skinfold**



Figure 3.7: Bicep skinfold measured using a skinfold calliper

Procedure: The bicep skinfold measurement was taken on the anterior surface of the arm at the level of the mid-acromial-radial landmark, parallel to the long axis of the arm (Marfell-Jones *et al.*, 2006) (see Figure 3.7).

iv. Supra-iliac skinfold



Figure 3.8: Supra-iliac skinfold measured using a skinfold calliper

Procedure: The participant's arm was placed across his/her chest while the measurement was taken. The supra-iliac skinfold was measured horizontally at the Iliac crest skinfold site (Marfell-Jones *et al.*, 2006) (see Figure 3.8).

v. Medial calf skinfold



Figure 3.9: Medial calf skinfold measured using a skinfold calliper

Procedure: The participant's right foot was placed on a box, with the knee bent at a 90° angle. The skinfold measurement was taken at the most medial part of the calf with the fold parallel to the long axis of the leg. The measurement was recorded at the level of maximal girth (Marfell-Jones *et al.*, 2006) (see Figure 3.9).

3.8.2.4. Circumference measurements

An inelastic, flexible tape measure was used to measure the calf and contracted arm circumference (ACSM, 2010) (see Figure 3.10).



Figure 3.10: Inelastic and flexible tape measure

i. Calf circumference



Figure 3.11: Calf circumference measured using a tape measure

Procedure: The participant stood with his/her feet shoulder-width apart and weight evenly distributed. The tape measure was placed around the maximal girth of the calf and recorded (Marfell-Jones *et al.*, 2006) (see Figure 3.11).

ii. **Contracted arm circumference**



Figure 3.12: Contracted arm measured using a tape measure

Procedure: The arm was flexed at an angle of 90 degrees and raised anterior to the horizontal. The tape measure was placed around the largest part of the biceps brachii. The circumference measurement was recorded when the subject contracted his/her arm (Marfell-Jones *et al.*, 2006) (see Figure 3.12).

iii. **Waist circumference**



Figure 3.13: Waist circumference measured using a tape measure

Procedure: The participant stood with his/her arms folded across the thorax, breathing normally. The measurement was recorded at the end of expiration at the narrowest part of the abdomen (Marfell-Jones *et al.*, 2006) (see Figure 3.13).

iv. Hip circumference



Figure 3.14: Hip measured using a tape measure

Procedure: The participant assumed a relaxed standing position, with the feet together, the gluteal muscles relaxed and the arms folded across the thorax. The measurement was recorded at the level of the greatest posterior circumference of the buttocks (Marfell-Jones *et al.*, 2006) (see Figure 3.14).

3.8.2.5. Diameter measurements

The humerus and femur diameter was measured using a small spreading calliper (Marfell-Jones *et al.*, 2006) (see Figure 3.15).

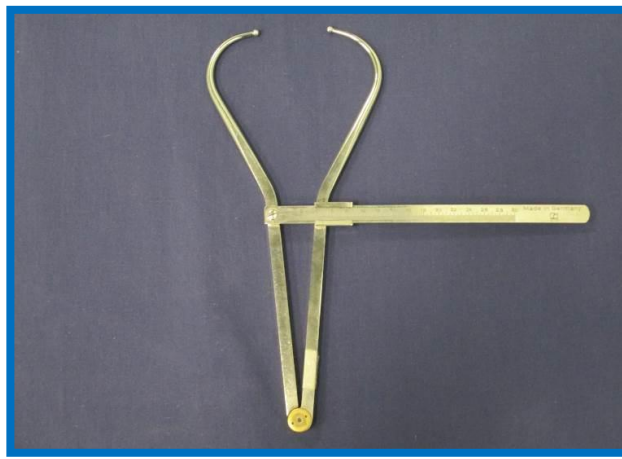


Figure 3.15: Small spreading calliper

i. Humerus diameter



Figure 3.16: Humerus diameter measured using a spreading calliper

Procedure: The participant bent his/her elbow at a 90° angle. The measurement was taken at the most medial aspect of the medial humeral epicondyle and the most lateral humeral epicondyle (Marfell-Jones *et al.*, 2006) (see Figure 3.16).

ii. Femur diameter



Figure 3.17: Femur diameter measured using a spreading calliper

Procedure: The participant was seated with his/her right leg bent at a 90° angle while the foot rested on the floor. The measurement was recorded at the most medial aspect of the medial femoral epicondyle and the most lateral aspect of the lateral femoral condyle (Marfell-Jones *et al.*, 2006) (see Figure 3.17).

3.8.3. Flexibility

Equipment: Sit-and-reach box (ACSM, 2010).



Figure 3.18: Starting position for modified sit-and-reach test



Figure 3.19: Measurement taken for the modified sit-and-reach test

Procedure: The participant performed the modified hurdler's stretch before the test to warm-up the muscles and reduce the risk of injury. The warm-up helped the participant to perform better in the test (ACSM, 2010). The participant sat with his/her back against a wall at an angle of 90 degrees, with the legs fully extended in front of his/her body, and the soles of the feet against the sit-and-reach box (Hoffman, 2006), wearing no shoes (ACSM, 2010). Arms were extended forward with one hand on top of the other. Scapula adduction was the only movement allowed (Hoffman, 2006). The zero point was measured from the point that the participant was able to reach in this position (see Figure 3.18). The subject leaned as far forward as possible, keeping his/her legs flat on the floor. The furthest distance reached by the fingertips was measured (Hoffman, 2006) (see Figure 3.19). The subject had two trials (ACSM, 2010) and the best measurement was recorded. The norms for the modified sit-and-reach test are given in Table 3.2.

Table 3.2: Norms for the modified sit-and-reach test

Percentile	Males	Females
99	62,7	53,3
95	48	49
90	43,7	45,5
80	43,2	42,4
70	40,1	41,1
60	38,1	40,1
50	36,6	37,6
40	34,3	36,8
30	33	34,8
20	29,5	32
10	23,4	25,7

(Hoffman, 2006).

3.8.4. Muscle strength

Equipment: Hand grip dynamometer (Nieman, 2003).



Figure 3.20: Hand grip dynamometer



Figure 3.21: Hand grip strength test using a dynamometer

Procedure: The hand grip dynamometer (T.K.K. 5401, Takei Scientific Instruments Co. Ltd, Japan) (see Figure 3.20) was adjusted to the hand grip size comfortable for the participant (Nieman, 2003). The participant stood upright with the elbow bent at a 90° angle. The shoulder was adducted and rotated neutrally. The forearm was in a neutral position and the wrist slightly extended from 0° to 30° (see Figure 3.21). The participant squeezed the dynamometer as hard as possible. There were three trials for each hand with a minute's rest between each trial. The best score was used as the measurement of the participant's muscle strength (Heyward, 2006). The norms for the hand grip strength test are given in Table 3.3.

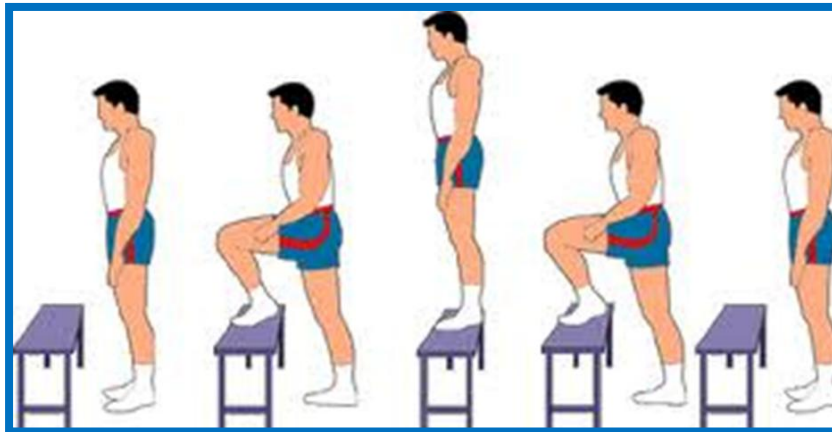
Table 3.3: Norms for combined right and left isometric grip strength scores

	Male	Female
Excellent	≥ 115	≥ 70
Very good	104–114	63–69
Good	95–103	58–62
Fair	84–94	52–59
Needs improvement	≤ 83	≤ 51

(Heyward, 2006)

3.8.5. Cardiovascular endurance

Equipment: Metronome, Harvard step, stopwatch



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Figure 3.22: Harvard step test



Figure 3.23: Metronome



Figure 3.24: Harvard step test



Figure 3.25: Stop watch

Procedure: The Harvard step test was used as it is a practical, reliable and valid test for measuring cardiovascular endurance (Phillips & Hornak, 1979; Bosco, 1983) (see Figure 3.22). During the test the participant steps up and down a bench to the sound of a metronome (Seiko, Quartz metronome Model SQ50V, Seiko Sports Life Co. Ltd, China) (see Figure 3.21). The metronome was set at a rhythm of 30 steps per minute. Male participants used a box 50 cm high whereas female participants used a box 40 cm high (see Figure 3.24). After four minutes for females and five minutes for males, the participant sat down immediately (Miller, 1994). His/her heart rate was recorded at the radial artery for 30 seconds. It was recorded at the 1st minute, 2nd minute and 3rd minute after the work had stopped (Krüger & Van Vuuren, 1998). A stopwatch was used to keep time (Sanji 5000 model) (see Figure 3.25).

The scoring formula used is given below:

$$\text{Index} = \frac{\text{Duration of the exercise in seconds}}{2 \times \text{sum of pulse counts in recovery}} \times 100$$

(Miller, 1994: 179)

The score obtained is interpreted according to the scores outlined in Table 3.4.

Table 3.4: Scores for the Harvard step test

Excellent	Above 89
Good	80–89
High average	65–79
Low average	55–64
Poor	Below 55

(Miller, 1994)

3.8.6. Muscle endurance

Equipment: Mat, stopwatch (Baechle & Earle, 2008)

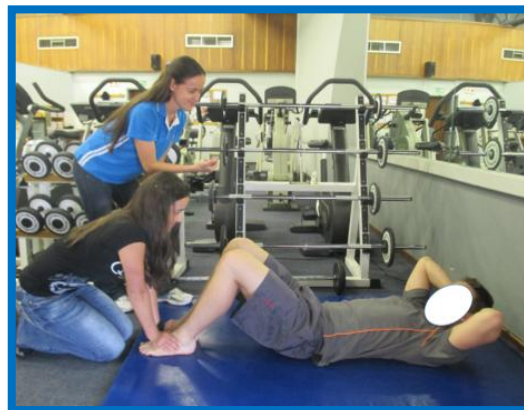


Figure 3.26: Starting position for the minute sit-up test

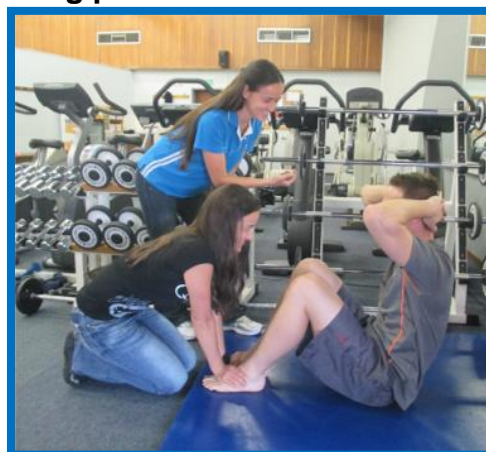


Figure 3.27: One minute sit-up test

Procedure: The participant lay in a supine position on a mat with his/her shoes on and his/her legs bent a 90° angle. The back of the participant's hands touched the mat with his/her fingers interlocked behind his/her neck. The participant's ankles were held firmly by another person, using only their hands (see Figure 3.26). On the "Go" command, the stopwatch (Sanji 5000 model) started counting the time, and the participant raised his/her upper body to the up position (see Figure 3.27). Once the participant's elbows touched his/her thighs the participant lowered the upper portion of his/her back until it touched the mat. The head, hands, arms and elbows did not have to touch the ground. The participant performed as many sit-ups as possible in a minute. A repetition did not count if the participant failed to reach the up position. If he/she failed to keep the fingers interlocked behind the neck, or if the participant raised the buttocks off the ground, the repetition did not count (Baechle & Earle, 2000). Norms for the minute sit up test are given in Table 3.5.

Table 3.5: Norms for the one minute sit-up test

Percentile rank	Male	Female
99	> 55	> 51
90	52	49
80	47	44
70	45	41
60	42	38
50	40	35
40	38	32
30	35	30
20	33	27
10	30	23
01	< 27	< 18

(Baechle & Earle, 2000)

3.9. Statistical analysis

The statistical analysis was done by a private statistician using IBM SPSS Statistics 22. The data analysis consisted of descriptive statistics and inferential statistics.

Under descriptive statistics, frequency analysis was used to describe the sample, and normal descriptive statistics was used to describe the minimum, average, maximum and standard deviation of the groups. Under inferential statistics, correlations were used. The Pearson's product-moment correlation coefficient was

used to test whether a relationship existed between the academic score and SES, health status and other biometric measures including body composition, flexibility, muscle strength, muscle endurance and cardiovascular fitness. To determine whether a statistical difference existed between the academic score of the cohort based on SES, health status and the components of physical fitness (measured as poor, average, good and excellent), a one-way analysis of the variance was used. T tests were used to assess differences between the independent variables. When comparing all the fitness measurements of the participants from January to June to October, repeated measurements ANOVA was used. The strength of the correlations was described in accordance with the classification of Landis and Koch (1977) as outlined in Table 3.6.

Table 3.6: Landis and Koch reliability classification scale

Interpretation	Association value
Poor	0,00
Slight	0,01–0,20
Fair	0,21–0,40
Moderate	0,41–0,60
Substantial	0,61–0,81
Almost perfect	0,81–1,00

The statistical level of reporting was set for the 95th percentile.



CHAPTER 4: RESULTS AND DISCUSSION

To recapitulate, the aim of this study was to determine whether there was a significant correlation ($p \leq 0,05$) between:

- Academic performance and body composition;
- Academic performance and muscle strength;
- Academic performance and flexibility;
- Academic performance and cardiovascular endurance;
- Academic performance and muscle endurance;
- Academic performance and health status; and
- Health status and the components physical fitness.

In addition, the study aimed to:

- Establish whether there was a significant difference between the student's AP score obtained in matric and his/her marks at university.

The results of the study are presented in tabular form (Tables 4.1 to 4.9) and graphic form (Figures 4.1 to 4.14). All statistically significant results were reported at the 95% level of confidence or greater, and are subsequently discussed in the context of the applicable literature.

The results are displayed in the following order:

- 4.1 Descriptive statistics of the sample;
- 4.2 Descriptive and correlational statistics of academic results with gender, mother's education, and degree studied;
- 4.3 Descriptive and correlational statistics of the measured variables;
- 4.4 Relationship between selected components of physical fitness;

- 4.5 Association between academic performance and the measured variables; and
- 4.6 Correlation between academic performance and measured variables from Test 1, Test 2 and Test 3.

4.1. Descriptive statistics of the sample

Participants were selected in accordance with the inclusion and exclusion criteria outlined in Section 3.5. The initial sample consisted of 100 participants. One of the 100 participant's data fell well outside the norm and was considered outlier data. The outlier's data was therefore not included in the sample which resulted in a final total of $n = 99$ (aged 17–33 years; 40 males and 59 females).

The sample size of 99 students is smaller than that in comparable studies. Eveland-Sayers *et al.* (2009) had 134 participants in their study, Du Toit *et al.* (2011) had 212 participants, Coe *et al.* (2006) had 214 participants and Kwak *et al.* (2009) and Castelli *et al.* (2007) had 232 and 259 participants, respectively. Yu *et al.* (2006) had a sample size of 333 participants, Dwyer *et al.* (1983) had 500 participants, and Sallis *et al.* (1999) had 759 participants. On a much larger scale, Sigfusdottir *et al.* (2007) examined 5 810 Icelandic school children and Tremblay *et al.* (2000) had 6 923 participants which is similar to the sample size of 6 463 used by Kim *et al.* (2003). Dwyer *et al.* (2001) included 7 961 Australian school children in their study. In studies examining the relationship between physical fitness and academic performance, the largest sample was gathered by The California Department of Education, namely 884 715 students (Grissom, 2005). The second largest sample size was that of Van Dusen *et al.* (2011) who studied 254 743 subjects.

Descriptive statistics in respect of age, gender, degree studied and mother's education are presented in Figure 4.1 to Figure 4.4. The academic score according to gender and mother's education is reflected in Figure 4.5. Figure 4.6 compares the academic and AP score of BA (HMS) and B (SportSci) students. Descriptive statistics of the sample in terms of waist circumference, hip circumference and waist/hip ratio are reflected in Figure 4.7 to Figure 4.8. Correlational and descriptive statistics for weight, health status, BMI, body fat percentage, cardiovascular endurance (Harvard step test), flexibility (sit-and-reach test), muscle strength (hand

grip dynamometer test) and muscle endurance (one minute sit-up test) are presented in Figure 4.9 to Figure 4.16.

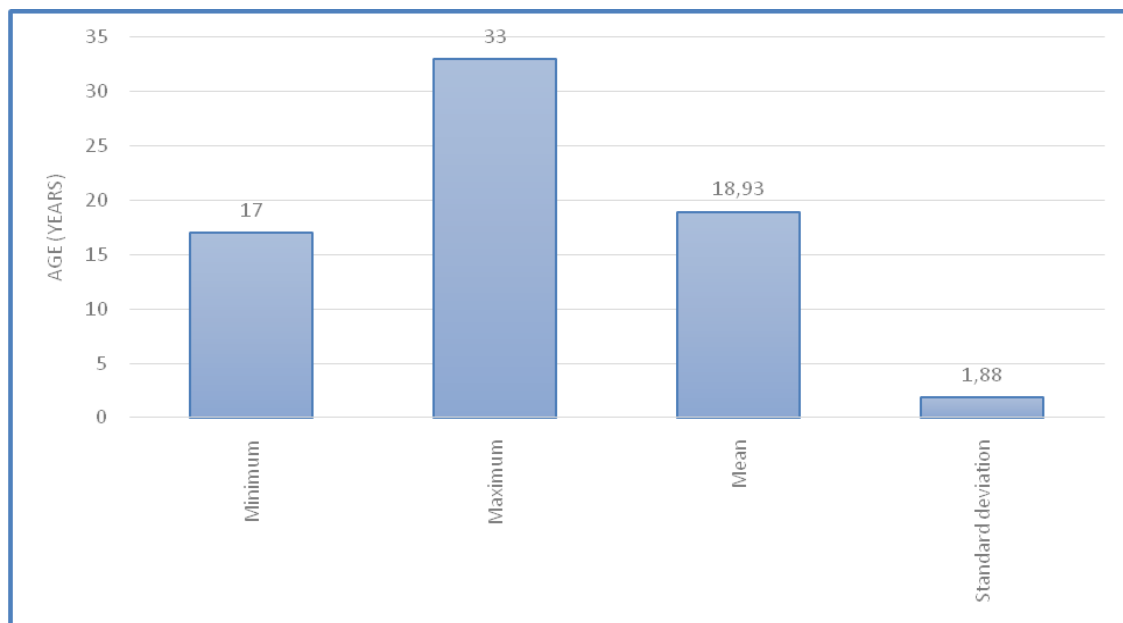


Figure 4.1: Variables of the study sample (age)

The mean age of the participants involved in this study was 18,93 years, with a standard deviation (SD) of 1,88 (Figure 4.1). To the researcher's knowledge, no study comparing the effects of physical fitness on academic performance has been done on university students rendering comparisons difficult. The majority of comparable studies were performed on young children and adolescents. When determining whether there is a correlation between physical activity and academic performance, Yu *et al.* (2006) studied pre-adolescent boys aged 8–12 years, Dwyer *et al.* (2001) studied Australian children aged 7–15 years, and Tremblay *et al.* (2000) examined 12-year-old children. Du Toit *et al.* (2011) studied South African children between the ages 9–12 years. Keeley and Fox (2009) investigated the effect of physical fitness and activity on academic achievement and cognitive performance in children aged 4–18 years, while Dwyer *et al.* (1983) investigated the effects of daily physical activity on the health of ten-year-old school children.

A Canadian study in the Trois Rivières region involved children from Grade 2, 3, 5 and 6 (Shephard, 1983; Shephard, 1997). Van Dusen *et al.* (2011) examined the associations between physical fitness and academic performance in Grade 3–11 school children, while Castelli *et al.* (2007) included 3rd and 5th Grade learners in

their study. Ahamed *et al.* (2007) used a similar age category to that used by Castelli *et al.* (2007) when determining whether school based physical activity compromised children's academic performance. Sallis *et al.* (1999) and Coe *et al.* (2006) studied Grade 6 children in the same context. However, Sallis *et al.* (1999) also included Grade 4 and 5 children in their investigation. Kim *et al.* (2003) examined a group of 5th, 8th and 11th Grade learners while the California Department of Education tested Grade 5, 7 and 9 learners (Grissom, 2005). When exploring the association between physical activity, fitness and academic achievement, the sample of Kwak *et al.* (2009) consisted of Grade 9 learners. Sigfusdottir *et al.* (2007) included Grade 9 and Grade 10 learners in their study, and Chomitz *et al.* (2009) used a large group of 4th to 8th Grade urban learners. Similar to the studies mentioned, Eveland-Sayers *et al.* (2009) examined the relationship between physical fitness and academic performance in elementary school children.

It is difficult to make accurate comparisons between past studies and the present one owing to the differences in the age groups studied. When determining the relationship between the components of physical fitness and academic performance, health status and academic performance, or health status and physical fitness, age may have contributed to a statistical significance or a lack thereof, owing to a higher or lower emphasis placed on the various parameters.

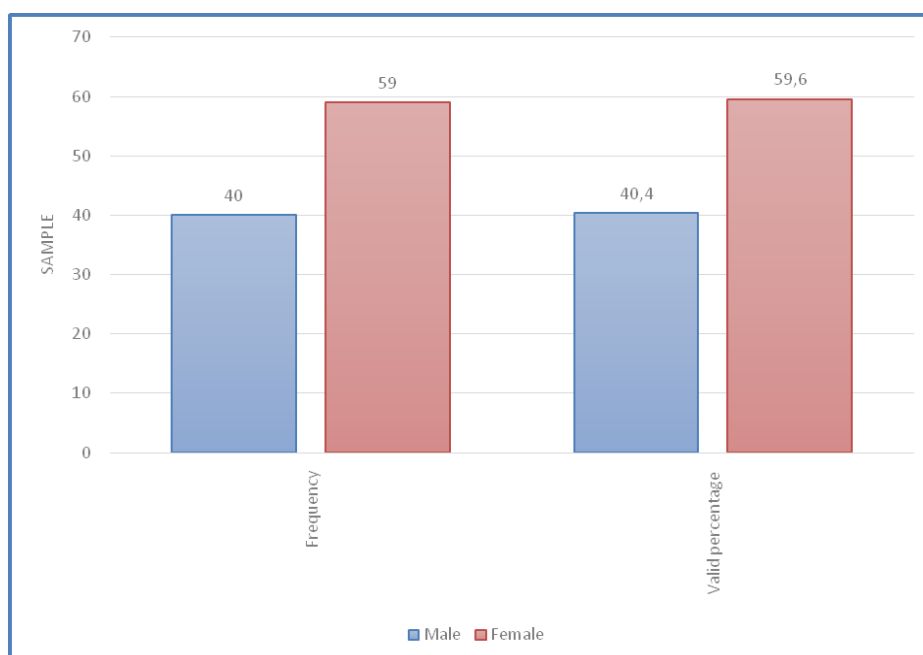


Figure 4.2: Variables of the study sample (gender)

There were 40,4% male participants and 59,6% female participants in this study (Figure 4.2). The majority of comparable studies included both male and female participants (Dwyer *et al.*, 1983; Sallis *et al.*, 1999; Tremblay *et al.*, 2000; Dwyer *et al.*, 2001; Kim *et al.*, 2003; Grissom, 2005; Coe *et al.*, 2006; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Kwak *et al.*, 2009; Van Dusen *et al.*, 2011). A study by Van Dusen *et al.* (2011) used a sample of 48,7% male and 51,3% female subjects. Kwak *et al.* (2009) had a similar ratio with 52% females participating in their study. The sample of Du Toit *et al.* (2011) included 94 male and 118 female subjects.

Since the majority of studies involved both male and female subjects, the present study can be compared to past studies in terms of gender.

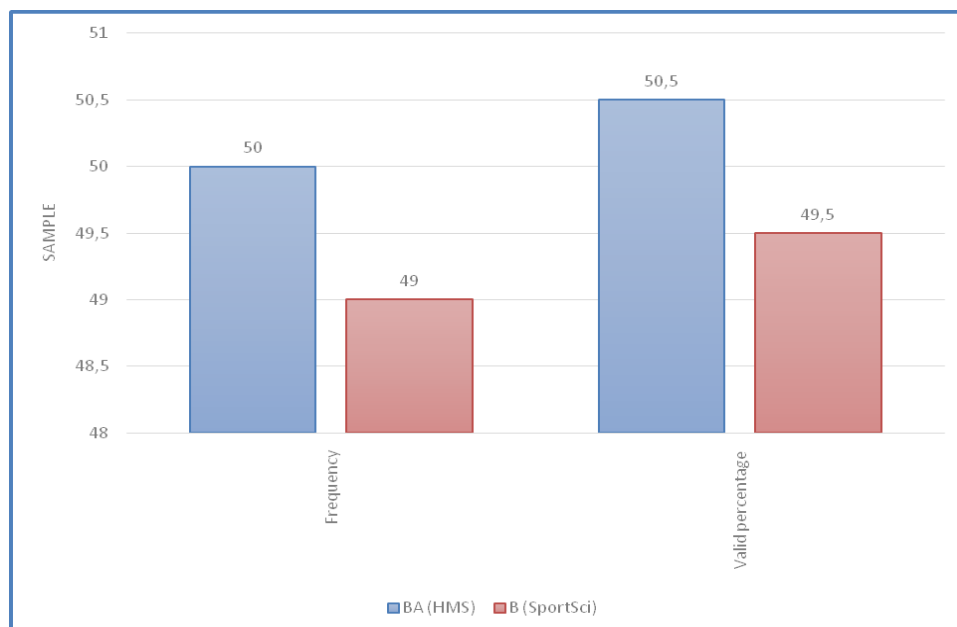


Figure 4.3: Variables of the study sample (degree studied)

The sample for the present study consisted of 50 BA (HMS) and 49 B (SportSci) students (Figure 4.3). These participants were selected from a sample of convenience available at the University of Pretoria.

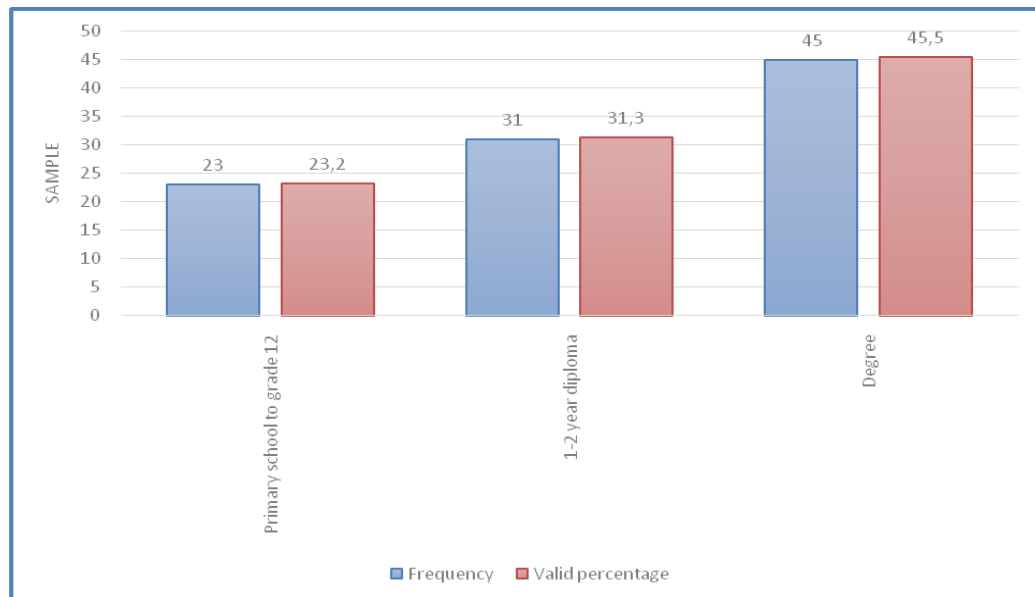


Figure 4.4: Variables of the study sample (mother's education)

This study followed the same principle as other studies (Kim *et al.*, 2003; Chomitz *et al.*, 2009; Kwak *et al.*, 2009) by using the participants' mothers' level of education as an indication of SES. The mothers were asked to rate their highest level of education in accordance with the following options:

- Primary school;
- Grade 10;
- Grade 12;
- One year diploma;
- Two year diploma;
- Three to four year degree;
- Honours degree;
- Master's degree; or
- Doctoral degree.

Owing to the lack of variation in answers regarding the lowest and highest levels of education, the data was arranged into three groups, which are represented in Figure 4.4 and listed below:

- Primary school to grade 12;
- One to two year diploma; and
- Undergraduate or postgraduate degree.

The mothers' of participants' educational levels were mostly grouped around the middle options, with only a few indicating an education level below Grade 12 or that of a postgraduate degree.

4.2. Descriptive and correlational statistics of academic results with gender, mother's education, and degree studied

No statistical significance between gender and academic performance (Figure 4.5) or gender and AP score was observed in the present study.

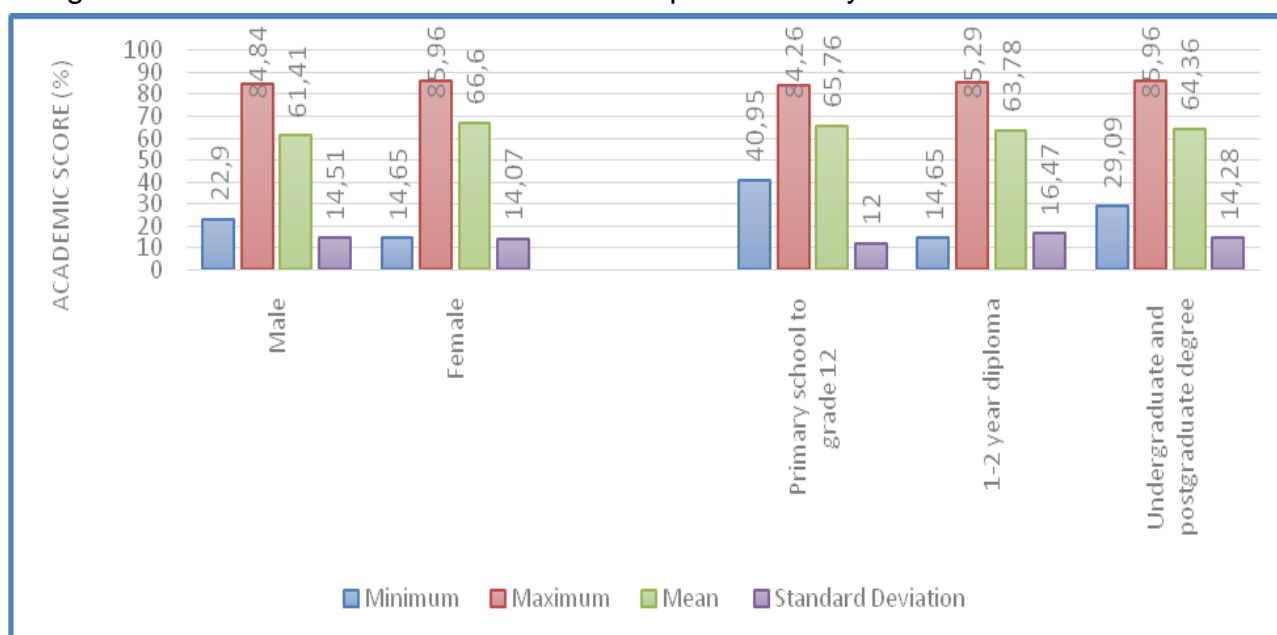


Figure 4.5: Academic score according to gender and mother's education

Du Toit *et al.* (2011) reported that females performed better academically than males but the difference was not statistically significant. Farooq *et al.* (2011) also indicated females to perform better academically than males. Evidence suggests that males suffer an educational disadvantage to females, especially in terms of performance in literacy. This could be owing to biological differences, teaching, assessment and gender bias. Some regard reading as being “non-masculine” (Considine & Zappalá, 2002). Borse *et al.* (2014) suggested that females have better study skills than males, they work harder and attend class more often. This did not appear to be the case in the present study.

The relationship between SES and academic performance showed no statistical significance on the basis of the mother's level of education (Figure 4.5). Kim *et al.*

(2003) showed a strong positive association between parental level of education and academic performance in Grade 5 and Grade 8 learners. A weak association was observed in Grade 11 boys and no association was reported in Grade 11 girls. A possible reason for the lack of significance in the present study could be the lack of variety in the mothers' levels of education. As mentioned previously, the majority of the mothers were grouped in the same category of educational level. The lack of significance could be because the mothers' education levels do not necessarily reflect the SES in this population group. All the participants in this study were university undergraduates whereas other comparable studies were done on school children (Dwyer *et al.*, 1983; Keays & Allison, 1995; Shephard, 1997; Sallis *et al.*, 1999; Tremblay *et al.*, 2000; Dwyer *et al.*, 2001; Kim *et al.*, 2003; Grissom, 2005; Coe *et al.*, 2006; Nelson & Gordon-Larsen, 2006; Burton & Van Heest, 2007; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Tomporowski *et al.*, 2008; Trudeau & Shephard, 2008; Chomitz *et al.*, 2009; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Kwak *et al.*, 2009; Welk *et al.*, 2010; Zoeller, 2010; Du Toit *et al.*, 2011; Shephard *et al.*, 2011; Van Dusen *et al.*, 2011; Al-Nader *et al.*, 2013; Liao *et al.*, 2013). Additionally the mother's level of education may not necessarily reflect household income. Other variables could play a role in determining a person's SES, including occupational status, families with two incomes, and unemployment (Considine & Zappalá, 2002; Farooq *et al.*, 2011). Causality based on SES alone can therefore not be assumed, as other variables could influence these outcomes independently.

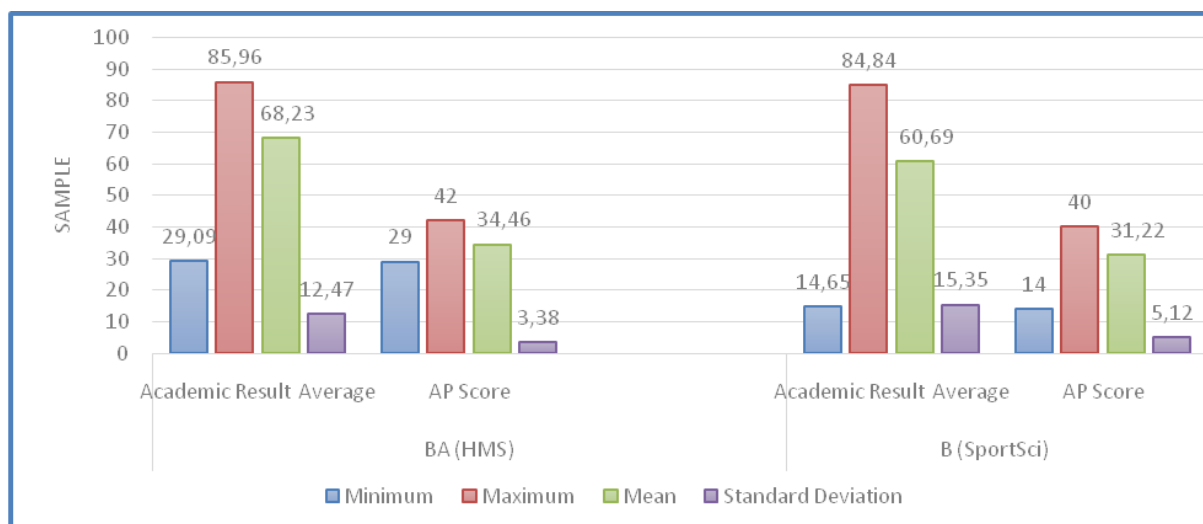


Figure 4.6: Comparison of BA (HMS) and B (SportSci) academic and AP scores

Statistically there was a significant relationship between degree studied and AP score, as well as degree studied and academic result average. The BA (HMS) students performed better academically in matric (AP score) and in their first year of university (academic result average) than the B (SportSci) students. Many of the B (SportSci) students are elite athletes who dedicate more of their time to their physical training whereas the BA (HMS) students may dedicate more of their time to their studies. This may explain why the BA (HMS) students performed better academically than the B (SportSci) students. In respect of the AP score, BA (HMS) participants scored $34,46 \pm 3,38$ compared to the B (SportSci) score of $31,22 \pm 5,12$ to the 99% confidence level ($p = 0,001$) (Figure 4.6). During their first year at university, the mean average academic score of the BA (HMS) students was $68,23 \pm 12,47$ compared to the mean academic score of $60,69 \pm 15,35$ in B (SportSci) students ($p = 0,01$) (Figure 4.6).

4.3. Descriptive and correlational statistics of the measured variables

Statistically there was no significant difference between the health status questionnaire and waist circumference, hip circumference and the waist/hip ratio.

The mean waist circumference (cm) of the sample for Test 1 was $72 \pm 7,95$ and $73,81 \pm 7,75$ and $74,12 \pm 7,86$ for Test 2 and 3 respectively (Figure 4.7). The mean hip circumference (cm) was $95,26 \pm 6,14$ for Test 1 and $95,99 \pm 6,17$ and $96,75 \pm 5,91$ for Test 2 and 3 respectively (Figure 4.7). The mean waist/hip ratio of the sample for Test 1, Test 2 and Test 3 was $0,76 \pm 0,65$, $0,77 \pm 0,07$ and $0,77 \pm 0,06$, respectively (Figure 4.8).

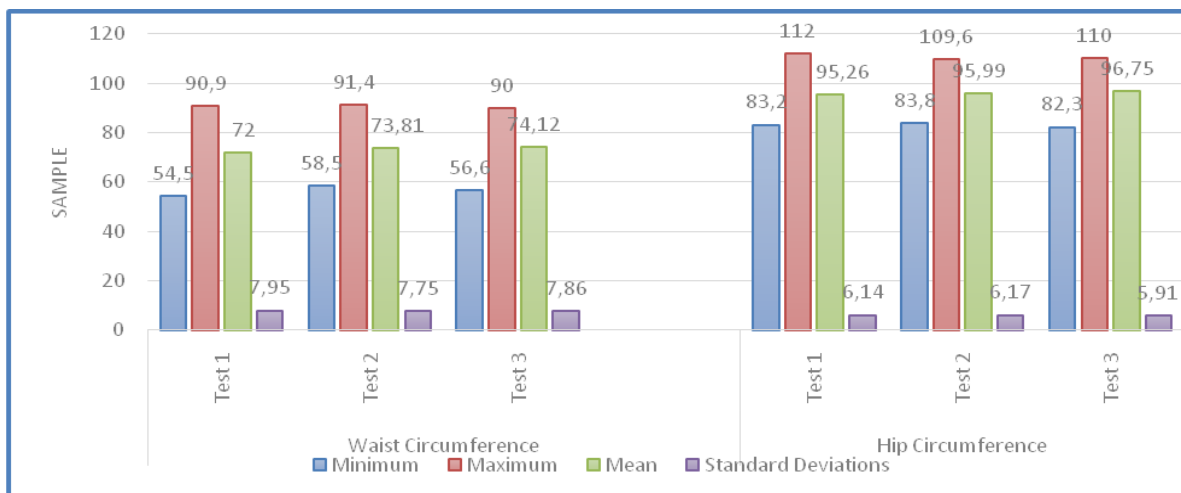


Figure 4.7: Descriptive statistics of the sample (waist circumference and hip circumference)

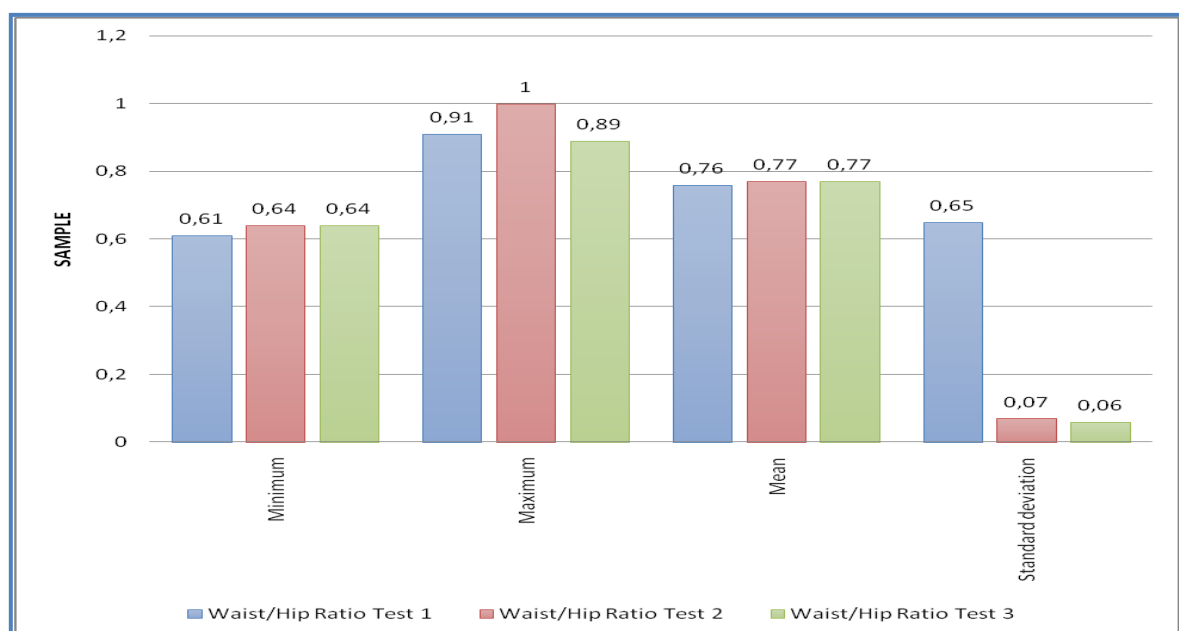


Figure 4.8: Descriptive statistics of the sample (waist/hip ratio)

There was a statistically significant difference in weight (kg) from Test 1 to Test 3 at the 99% confidence level ($p < 0,001$). The mean weight for Test 1 was $64,88 \pm 12,02$. This had increased to $68,3 \pm 12,52$ by Test 3 (Figure 4.9).

The change in weight observed in this study supports research which has documented that University students have a tendency to gain weight in their first year of study (Wengreen & Moncur, 2009). This has been attributed to a lifestyle free from parental influence (Stewart-Brown *et al.*, 2000).

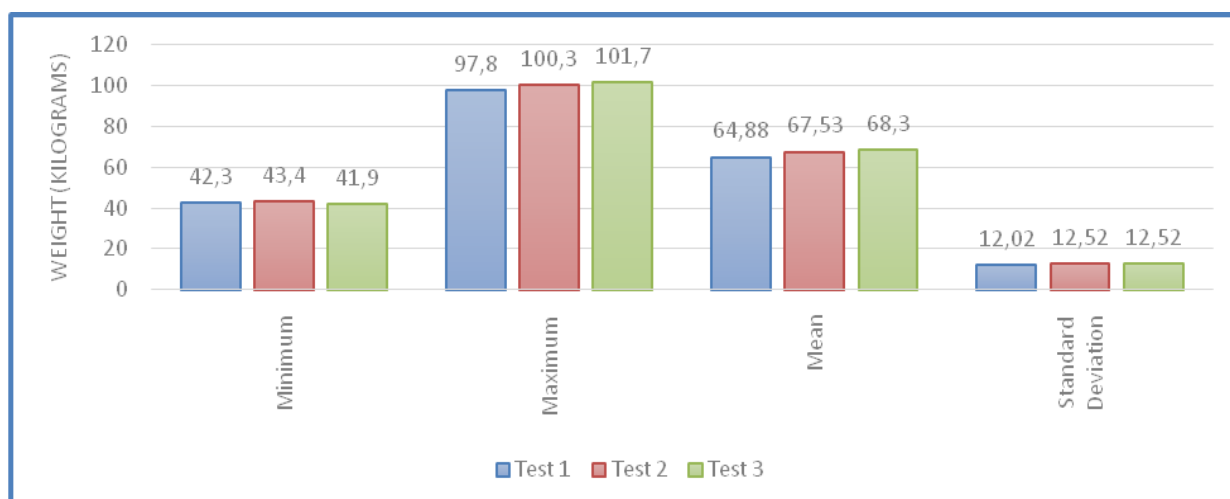


Figure 4.9: Variables of the study sample (weight)

The majority of participants were classified in the healthy lifestyle category (Figure 4.10) with a normal BMI (Figure 4.11). This was similar to the sample used in the study by Du Toit *et al.* (2011) where the mean BMI was also classified as “normal”. There was little change through the year with regard to lifestyle category and BMI results in the present study. There was a greater variation through the year with regard to fat percentage (Figure 4.12).

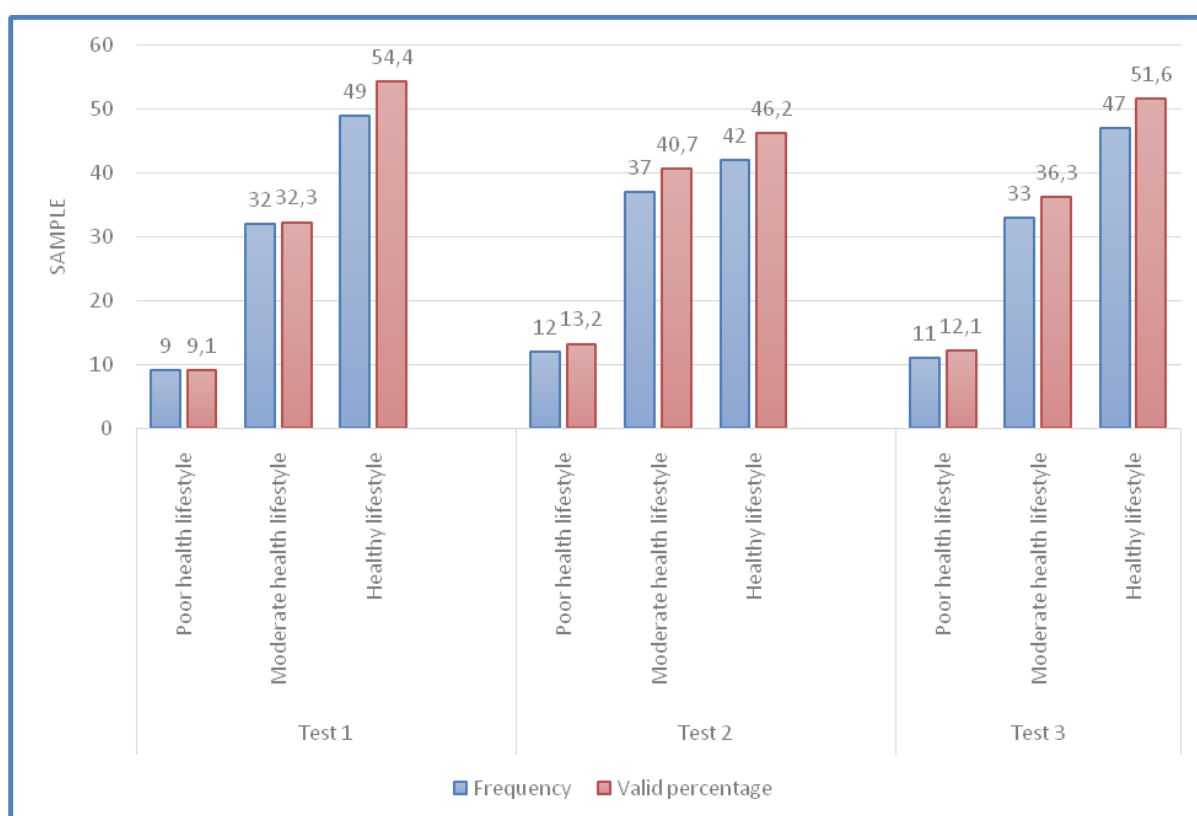


Figure 4.10: Variables of the study sample (health status)

Statistically, there was no significant change in the health and lifestyle questionnaire scores between the three tests.

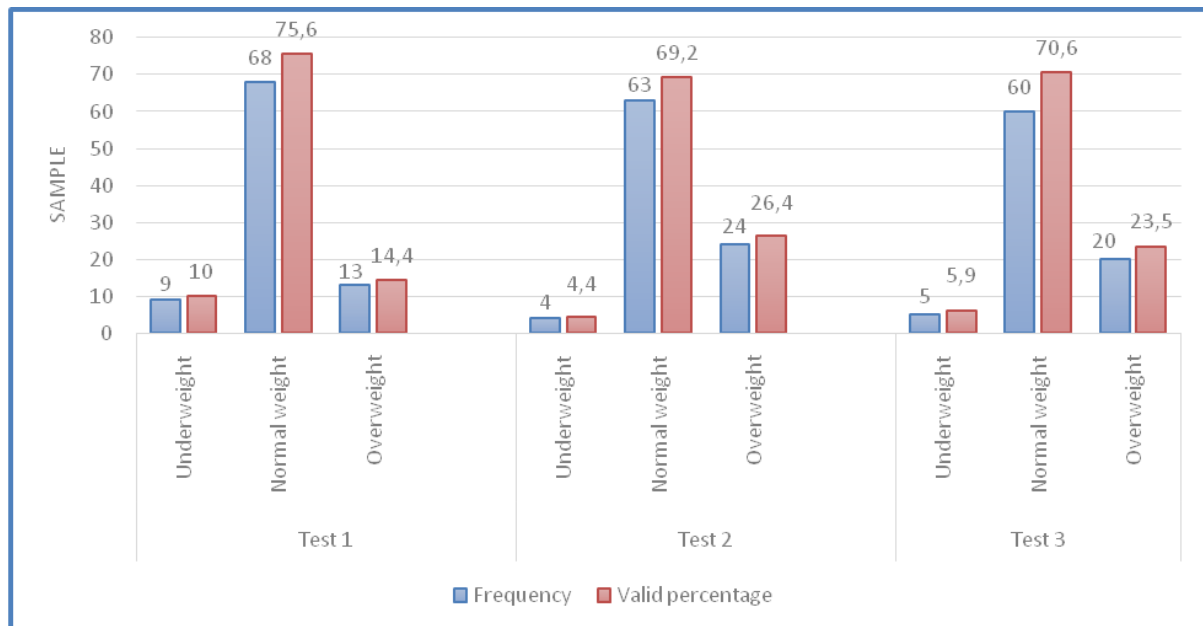


Figure 4.11: Variables of the study sample (BMI)

The change was not clinically significant (Figure 4.11). A significant increase ($p < 0,001$) in mean BMI (kg.m^{-2}) was observed between Test 1 ($22,17 \pm 2,8$) and Test 2 ($22,89 \pm 2,83$) and Test 1 and Test 3 ($22,85 \pm 2,83$). Despite the statistical significance these changes cannot be seen as being clinically significant. Similar studies tested participants on one occasion only, making comparisons with the present study not possible.

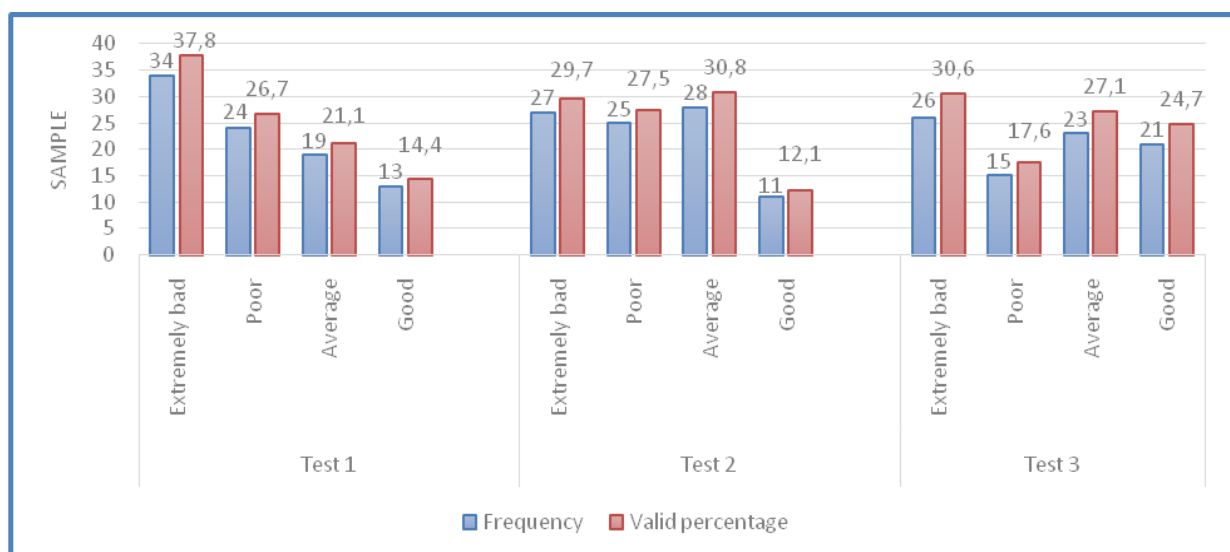


Figure 4.12: Variables of the study sample (percentage body fat)

There was a statistically significant change in the fat percentage to the 95% confidence level ($p < 0,05$) but again this was interpreted not to be clinically significant. The mean body fat percentage decreased significantly from $21,94 \pm 6,95$ for Test 1 to $20,65 \pm 6,58$ for Test 2 and $20,23 \pm 7,70$ for Test 3. The increase in weight and increase in BMI (Figures 4.9 and 4.11), and the decrease in body fat percentage from the beginning of the year to the end of the year (Figure 4.12), could indicate that participants had gained muscle mass. With a mean age of 18,93 years, one could suspect that the changes in muscle mass could be related to growth, development and hormones, particularly in the male participants. During adolescence and early adulthood testosterone levels are at their highest. Testosterone is a robust hormone that promotes muscle mass. A deficiency of testosterone leads to a decrease in muscle mass and an increase in fat mass (Severson & Barclay, 2015). Growth hormone could also explain the increase in muscle mass and decrease in the percentage fat. Growth hormone increases fat breakdown to provide energy for tissue growth. A deficiency in growth hormone in children and adults is accompanied by an increase in adipose tissue (Bengtsson *et al.*, 1992). The BA (HMS) and B (SportSci) courses involve physical exercise training. This could be an alternate reason for the observed increase in muscle mass and decrease in the percentage body fat.

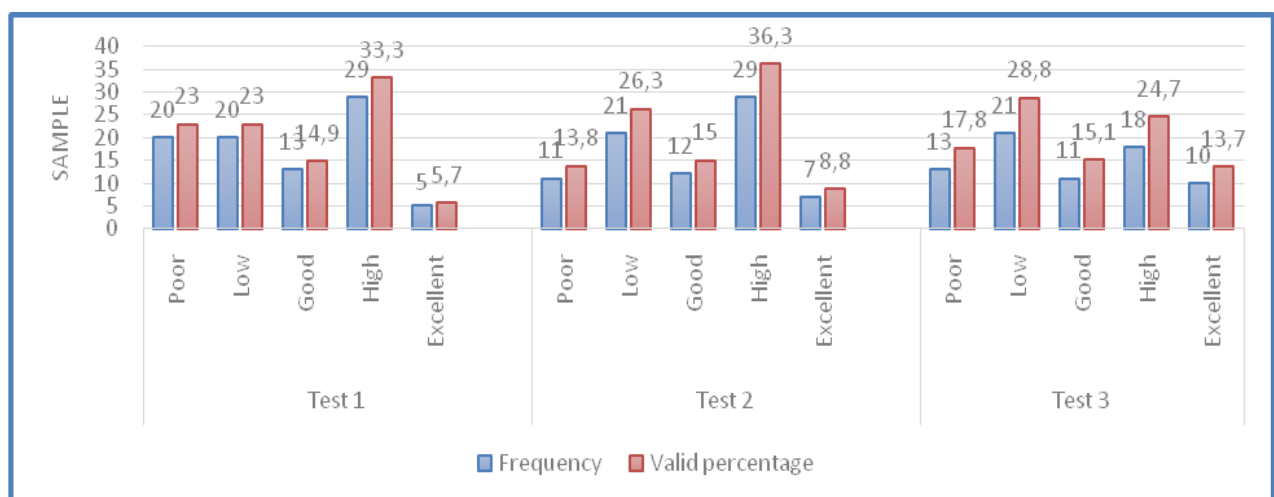


Figure 4.13: Variables of the study sample (cardiovascular endurance)

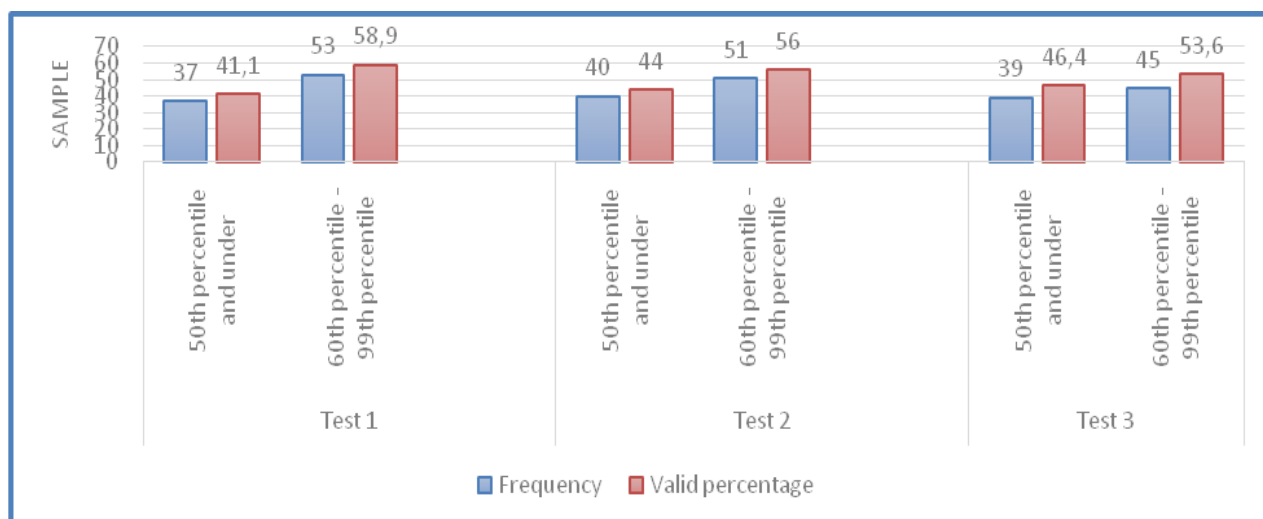


Figure 4.14: Variables of the study sample (flexibility)

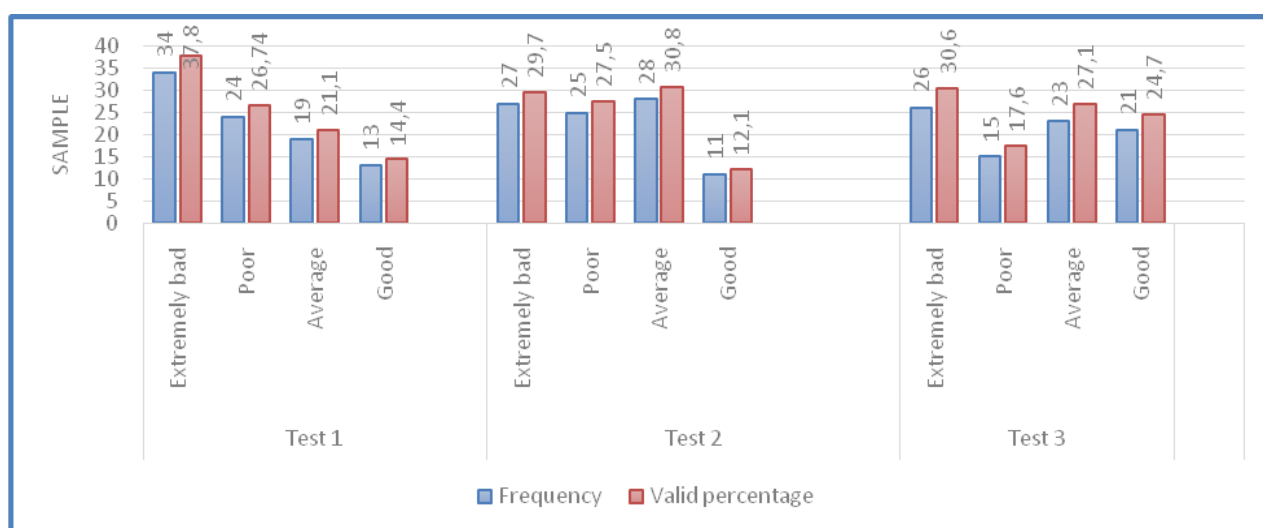


Figure 4.15: Variables of the study sample (muscle strength)

Despite the participants being enrolled for courses that require practical sessions of physical exercise, there was no statistically significant change through the year in their cardiovascular endurance (Figure 4.13), flexibility (Figure 4.14), and muscle strength (Figure 4.15). Despite the proposed increase in muscle mass mentioned before, muscle strength did not show any improvement. This could be owing to the method of strength testing (by means of a hand grip dynamometer) that use different muscle groups from the muscle groups used in their respective sports, e.g. soccer.

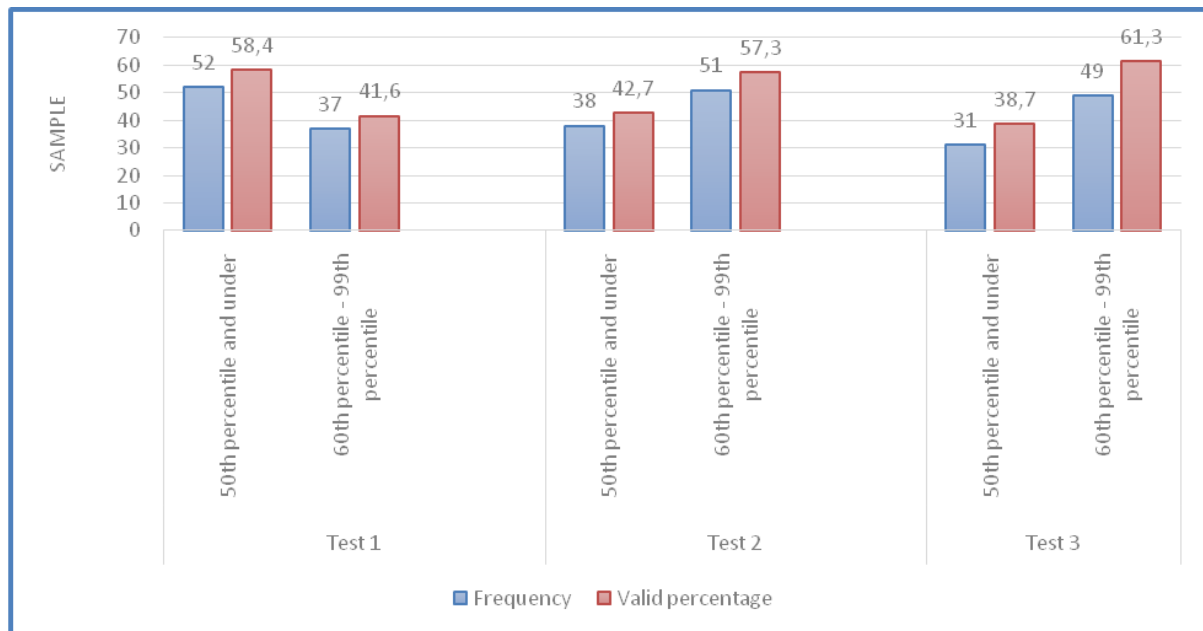


Figure 4.16: Variables of the study sample (muscle endurance)

The one minute sit-up test (Figure 4.16) demonstrated a statistically significant change through the year on the 99% confidence level ($p < 0,001$). The mean number of sit-ups performed in Test 1 significantly increased from Test 1 ($37,40 \pm 8,98$, $p < 0,001$) to Test 2 ($41,36 \pm 9,86$, $p < 0,001$), and from Test 2 to Test 3 ($42,20 \pm 10,47$, $p < 0,001$). A possible reason for the improvements may be that participants became familiar with the test.

As stated previously, the present study tested participants on three separate occasions whereas comparable studies tested participants on one occasion only. Comparisons between this study and past studies can therefore not be made in terms of the change in the components of physical fitness from the beginning of the year to the end of the year.

4.4. Relationship between selected components of physical fitness

Physical fitness is an interrelated, individualised concept that consists of five components. To investigate the effect of physical fitness on academic performance, the association between these components was investigated (Table 4.1).

Table 4.1: Correlation analysis between selected components of physical fitness

Correlation	Significance (p)	Strength of correlation (r)
Flexibility vs muscle strength	p = 0,04	Fair (-0,22)
Muscle endurance vs muscle strength	p < 0,001	Moderate (0,42)
Cardiovascular endurance vs muscle strength	p < 0,001	Fair (0,34)
Muscle endurance vs cardiovascular endurance	p < 0,001	Moderate (0,54)

When comparing the components of physical fitness to one another, a statistically significant negative relationship was seen between muscle strength and flexibility (p = 0,04; r = -0,22). This confirms the statement of Heyward (2006) that the size and strength of muscles could limit flexibility. A statistically significant positive relationship was seen between muscle strength and muscle endurance (p < 0,001; r = 0,42), and between muscle strength and cardiovascular endurance (p < 0,001; r = 0,34) (Table 4.1). Any physical exercise training that improves muscle endurance will also improve muscle strength, and vice versa (Baechle & Earle, 2008). Though cardiovascular endurance training does not lead to an improvement in muscle strength, anaerobic training programmes can lead to an increase in both muscle strength and aerobic power, depending on the method of application (Baechle & Earle, 2008). Muscle endurance had a moderately positive relationship with cardiovascular endurance (p < 0,001; r = 0,54) in the present study. Cardiovascular endurance training can improve both cardiovascular endurance and muscle endurance at a lower power output (Baechle & Earle, 2008). This study demonstrates the reciprocity among the various components of physical fitness. Comparable studies done in the past failed to compare the components of physical fitness with one another. Comparisons between this study and past studies in terms of the relationship among the components of physical fitness can therefore not be made.

4.5. The association between academic performance and measured variables

A mean value for the three tests was determined for each of the measured variables and correlated with academic performance (Table 4.2).

Table 4.2: Correlation analysis of academic performance with the mean of measured variables

Correlation	Significance (p)	Strength of correlation (r)
Academic performance vs AP score	$p < 0,001$	Moderate (0,55)
Academic performance vs health status	$p = 0,007$	Fair (0,28)
Academic performance vs height	$p = 0,02$	Fair (-0,25)
Academic performance vs weight	$p < 0,001$	Fair (-0,38)
Academic performance vs BMI	$p = 0,002$	Fair (-0,33)
Academic performance vs waist circumference	$p = 0,02$	Fair (-0,25)
Academic performance vs hip circumference	$p = 0,002$	Fair (-0,33)
Academic performance vs muscle strength	$p = 0,03$	Fair (-0,23)

When comparing academic performance to the AP score there was a moderately strong positive relationship ($p < 0,001$; $r = 0,55$) (Table 4.2). When comparing academic score to height ($p = 0,02$; $r = -0,25$), weight ($p = < 0,001$; $r = -0,38$), waist circumference ($p = 0,02$; $r = -0,25$), hip circumference ($p = 0,002$; $r = -0,33$), and muscle strength ($p = 0,03$; $r = -0,23$) there was a fairly negative relationship. Statistically there was no significant relationship between AP score and any other measured variable. The time difference from when the AP score was measured to when the variables were measured was too great to be able to draw any significant conclusions.

To the researcher's knowledge no other published studies have compared tertiary academic performance to school AP scores. However, the positive association between the AP score and academic performance in the present study could be explained by Behr (1985) who stated that a student who performs well at school tends to acquire a sound attitude towards work.

While the present study showed a fair negative relationship between height and academic performance, Kim *et al.* (2003) found a weak but positive association between height and academic performance in Grade 5 girls and Grade 8 boys. The association was stronger at younger ages. Nutrition influences development and growth (i.e. height) in children. Taller children may be indicative of better nutrition and, as stated previously, nutrition affects cognitive performance, which in turn has a positive effect on academic performance (Kim *et al.*, 2003; Woodward, 2009). Owing to the age group used in the present study, there is no explanation for the fairly negative relationship between height and academic performance. Further studies should be undertaken to investigate the association between these two components.

A number of studies suggest that overweight children have lower academic achievement scores (Datar & Sturm, 2006; Castelli *et al.*, 2007; Cottrell *et al.*, 2007; Welk *et al.*, 2010) than children within the normal weight range. This corresponds to the present study which shows an inverse relationship between weight and academic results. Du Toit *et al.* (2011) had similar findings, but only among girls and not among boys. Kim *et al.* (2003), however, reported no significant relationship between body weight and academic performance. In contrast to this research, Alonso-Alonso and Pascual-Leone (2007) and Li *et al.* (2008) observed a link between overweight and cognitive factors, which in turn relates to academic achievement. Comparisons between this study and other studies are confounded by the difference in age groups.

According to Pathrudu (2015), there was no significant correlation between academic performance and waist and hip circumference. The present study however, observed a fairly negative relationship between waist circumference and academic performance, and between hip circumference and academic performance. This could be explained by the fact that a large waist circumference is associated

with metabolic syndrome and increased morbidity (Pathrudu, 2015). Visceral adipose tissue is negatively associated with verbal memory and attention (Isaac *et al.*, 2011).

Limited research has been done on the association between muscle strength and cognition. Du Toit *et al.* (2011) noted a positive correlation ($p < 0,05$) with medium practical significance between muscle strength and academic performance. Dwyer *et al.* (2001) and Van Dusen *et al.* (2011) also showed a positive association between the two components, while Castelli *et al.* (2007) reported no significant association. Muscle strength has been shown to be associated with overall health (Plowman & Smith, 2014), and overall health has been shown to be associated with academic performance (Table 4.2), however in the present study muscle strength does not appear to independently affect academic performance (Table 4.7).

The relationship between academic performance and health status, and academic performance and BMI is discussed in Section 4.6.

While some studies reported certain components of physical fitness to influence academic performance (Dwyer *et al.*, 2001; Castelli *et al.*, 2007; Eveland-Sayers *et al.*, 2009; Keeley & Fox, 2009; Du Toit *et al.*, 2011; Van Dusen *et al.*, 2011), the present study did not observe any significant correlation between academic performance and the percentage body fat, waist/hip ratio, flexibility, muscle endurance and cardiovascular endurance. A possible explanation for the difference in results is the difference in age groups of the sample groups. Du Toit *et al.* (2011) found that the percentage body fat did not influence academic performance. This correlates with the present study. No studies which were consulted used the waist/hip ratio, and therefore no comparisons can be drawn. Health is related to academic performance (Table 4.2); however, those with a higher percentage of fat are not necessarily unhealthy.

While studies have demonstrated a negative association between waist/hip ratio and academic scores (Borse *et al.*, 2014; Pathrudu, 2015), the current study found no association. A higher waist/hip ratio may be owing to a lack of physical activity, which could be responsible for a lower amount of mental processing and brain activity (Borse *et al.*, 2014).

Evidence that relates flexibility to cognition is limited. Studies comparing flexibility to academic performance have yielded mixed results. A significant correlation was observed by Van Dusen *et al.* (2011) in respect of academic performance and performance in the sit-and-reach test ($p < 0,05$). Castelli *et al.* (2007) however observed flexibility to be unrelated to academic achievement, which is in line with the present study. Flexibility exercises lead to a wide range of chemical and neural adaptations in the brain, increasing one's ability to think critically (Kramer *et al.*, 2006). This does not appear to be the case in this study.

Although some studies have reported a positive association between academic test scores and muscle fitness (Dwyer *et al.*, 2001; Eveland-Sayers *et al.*, 2009), as well as between health status and academic performance (Kim *et al.*, 2003; Chomitz *et al.*, 2009), Castelli *et al.* (2007) reported no association between these components. The present study agrees with the findings of Castelli *et al.* (2007) on muscle fitness and academic performance, which show that muscle endurance does not appear to have an independent effect on academic performance. Muscle endurance improves health by reducing the risk of illness and chronic disease (Warburton *et al.*, 2006). It has a positive effect on metabolic health and cardiovascular risk factors (Plowman & Smith, 2014) and has been shown to improve psychological well-being and overall quality of life (Warburton *et al.*, 2006; Plowman & Smith, 2014). While Du Toit *et al.* (2011) observed a medium correlation between muscle endurance and academic performance, Ruiz *et al.* (2010) saw no association between muscle endurance and cognitive performance.

Van Dusen *et al.* (2011) observed a statistical significant association ($p < 0,001$) between cardiovascular endurance and academic performance. Numerous studies have also reported a positive association between cardiovascular endurance and academic performance (McAuley *et al.*, 1994; Dwyer *et al.*, 2001; Castelli *et al.*, 2007; Sigfusdottir *et al.*, 2007; Eveland-Sayers *et al.*, 2009; Welk *et al.*, 2010; Van Dusen *et al.*, 2011), as well as with cognitive abilities (Etnier *et al.*, 1997; Colcombe *et al.*, 2003; Colcombe & Kramer, 2003). When examining which component(s) of physical fitness had the strongest association with academic performance, cardiovascular endurance and body composition were generally shown to have the strongest link. These two components are associated with risk factors for chronic

disease, which could explain the positive association (Van Dusen *et al.*, 2011). This did not appear to be the case in this study. A possible reason for this difference could be due to the method of testing used. Studies have shown that cardiovascular endurance was strongly associated with academic performance when field tests were used to measure cardiovascular endurance (Dwyer *et al.*, 2001; Castelli *et al.*, 2007; Eveland-Sayers *et al.*, 2009). Coe *et al.* (2006) stated that the level of physical activity is important when examining the relationship between physical fitness and academic performance. This correlates with the findings of Kwak *et al.* (2009) who showed that vigorous physical activity was the only level of intensity that had a significant association with academic achievement. This could be an alternate reason for the lack of statistical significance in the present study.

4.6. Correlation between academic performance and measured variables in Test 1, Test 2 and Test 3

The combined mean for the three tests in terms of health status showed a fairly positive relationship ($p = 0,007$; $r = 0,28$) with academic performance (Table 4.2).

Table 4.3: Correlation between academic performance and health status

Health status	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
Healthy lifestyle	49	68,12 \pm 13,13*	42	66,02 \pm 12,72•	47	68,86 \pm 13,89
Moderate health lifestyle	32	63,56 \pm 13,41	37	65,18 \pm 16,09	33	66,22 \pm 16,18
Poor health lifestyle	9	52,84 \pm 19,02*	12	58,32 \pm 15,23•	11	58,24 \pm 11,75

- * Statistical significance found between healthy lifestyle and poor health lifestyle category (Test 1)
- Statistical significance found between healthy lifestyle and poor health lifestyle category (Test 2)

Test 1

There was a statistically significant relationship between academic performance and overall health status in Test 1 ($p = 0,01$). When comparing academic performance

and lifestyle categories (poor health lifestyle, moderately healthy lifestyle and healthy lifestyle), there was a statistically significant difference between participants in the healthy lifestyle category and those in the poor health lifestyle category ($p = 0,02$) (Table 4.3).

Test 2

Statistically there was no significant relationship between academic performance and total health status in Test 2. There was a significant positive correlation between academic performance and the healthy lifestyle and poor health lifestyle categories ($p = 0,02$) (Table 4.3).

Test 3

Statistically there was no significant relationship between academic performance and total health status, or between academic performance and the health status categories in Test 3 (Table 4.3).

The results of this study correlate with the results from the studies by Kim *et al.* (2003) and Chomitz *et al.* (2009), which showed academic success to be influenced by health. Ansari & Stock (2010) reported that health complaints influence a student's capacity to perform adequately at university, possibly because ill students tend to miss class, which has a negative effect on academic success (Jensen, 1998; Keeley & Fox, 2009; Mujović & Čubrilo, 2012).

When comparing the individual components of physical fitness with the health status questionnaire, there was no statistically significant relationship between the two. According to Kim *et al.* (2003) and Chomitz *et al.* (2009) physical fitness is related to health status, but in this study the individual components of physical fitness do not seem to be related to health status.

The majority of the participants from the present study selected the healthy lifestyle category, with most of the remainder choosing the moderately healthy lifestyle category. Very few participants selected the poor health category. The majority of subjects in the study by Ansari & Stock (2010) perceived their health to be good to excellent. If more participants had selected the poor and moderately healthy status

categories, stronger associations with academic performance may have been observed.

Table 4.4: Correlation between academic performance and body mass index

Body mass index	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
Underweight	9	74,23 \pm 7,82*	4	70,87 \pm 9,34	5	67,54 \pm 7,39
Normal weight	68	65,74 \pm 13,84	63	67,24 \pm 13,55•	60	66,95 \pm 14,66
Overweight	13	56,41 \pm 17,57*	24	56,38 \pm 14,99•	20	58,72 \pm 16,08

- * Statistical significance between Test 1 underweight and Test 1 overweight category
- Statistical significance between Test 2 normal weight and Test 2 overweight category

The mean BMI from the three tests in combination showed a fairly negative, yet significant relationship to academic performance ($p = 0,002$; $r = -0,33$) (Table 4.2).

Test 1

There was a statistically significant relationship between academic performance and the mean BMI with Test 1 ($p = 0,02$). When comparing the BMI categories (underweight, normal weight and overweight) to academic performance, there was a statistically significant difference ($p = 0,006$) between the participants who were underweight and overweight (Table 4.4).

Test 2

A statistically significant relationship was seen between academic performance and mean BMI with Test 2 ($p = 0,003$). The difference was statistically significant between the normal weight and overweight participants ($p = 0,001$) in a comparison of the BMI categories with academic performance (Table 4.4).

Test 3

Test 3 showed no significant difference with regard to BMI and academic performance or with the BMI categories and academic performance (Table 4.4).

Corresponding with the results from Test 1 and Test 2, Castelli *et al.* (2007) and Cottrell *et al.* (2007) reported a significant and inverse relationship between BMI and academic performance. Welk *et al.* (2010) noticed a positive association between normal BMI scores and academic success. Van Dusen *et al.* (2011) stated that a moderate BMI was better associated with academic achievement than low BMI scores and high BMI scores, while Du Toit *et al.* (2011) demonstrated that an overweight status had an adverse effect on academic performance in females but not in males. Li *et al.* (2008) observed an association between BMI and cognitive impairment. Those with a poorer BMI percentile performed poorer in cognitive tasks. The association is partially explained by reverse causation. Obese children and adults often choose a lifestyle with poor dietary habits, low physical activity levels and much television viewing, which promotes weight gain and exacerbates risk factors for cardiovascular disease such as diabetes mellitus. Hyperinsulinemia is associated with disturbances in glucose metabolism that may affect several brain regions involved in planning and organising. Another possible reason for the association is that obesity is related to sleep apnea, which is related to cognitive deficits. No significant relationship between BMI and academic scores was observed by Eveland-Sayers *et al.* (2009) and Ruiz *et al.* (2010).

Table 4.5: Correlation between academic performance and body fat percentage

Body fat percentage	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
Good	13	68,95 \pm 12,97	11	72,00 \pm 12,51	21	67,62 \pm 12,11
Average	19	67,98 \pm 11,06	28	64,40 \pm 12,30	23	62,53 \pm 15,78
Poor	24	64,06 \pm 14,63	25	66,13 \pm 16,55	15	67,74 \pm 16,40
Extremely bad	34	63,14 \pm 16,63	27	60,59 \pm 14,90	26	63,63 \pm 15,79

Table 4.6: Correlation between academic performance and flexibility

Flexibility	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
50th percentile and under	37	62,72 \pm 15,66	40	62,92 \pm 15,35	39	63,61 \pm 15,66

Flexibility	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
60th to 99th percentile	53	67,00 \pm 13,55	51	65,85 \pm 13,95	45	66,62 \pm 14,60

Table 4.7: Correlation between academic performance and muscle strength

Muscle strength	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
Excellent	11	59,60 \pm 14,95	9	65,66 \pm 10,05	13	63,45 \pm 14,61
Very good	16	61,96 \pm 20,35	14	58,93 \pm 18,19	14	63,96 \pm 19,02
Good	13	63,21 \pm 14,51	26	64,17 \pm 14,37	18	64,56 \pm 17,42
Fair	30	68,54 \pm 11,85	26	63,79 \pm 15,27	25	63,39 \pm 11,91
Needs improvement	20	67,34 \pm 12,01	16	71,32 \pm 10,91	15	70,90 \pm 13,06

Table 4.8: Correlation between academic performance and muscle endurance

Muscle endurance	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
50th percentile and under	52	65,57 \pm 12,51	38	63,33 \pm 14,95	31	64,28 \pm 14,07
60th to 99th percentile	37	65,13 \pm 17,18	51	65,62 \pm 14,13	49	65,54 \pm 15,94

Table 4.9: Correlation between academic performance and cardiovascular endurance

Cardiovascular endurance	n	Academic result compared to Test 1 (mean \pm SD)	n	Academic result compared to Test 2 (mean \pm SD)	n	Academic result compared to Test 3 (mean \pm SD)
Excellent	5	59,30 \pm 21,68	7	62,71 \pm 13,40	10	59,98 \pm 17,28 †
High	29	65,84 \pm 17,04	29	64,89 \pm 13,56	18	62,60 \pm 13,43 ‡
Good	13	67,27 \pm 13,62	12	64,35 \pm 16,48	11	74,59 \pm 8,58 •†‡
Low	20	68,73 \pm 10,28	21	70,68 \pm 9,38	21	67,22 \pm 18,69 *
Poor	20	60,91 \pm 12,81	11	54,67 \pm 19,28	13	61,38 \pm 13,01 •*

- * *Statistical significance between poor and low cardiovascular endurance in Test 3*
- *Statistical significance between poor and good cardiovascular endurance in Test 3*
- † *Statistical significance between excellent and good cardiovascular endurance in Test 3*
- ‡ *Statistical significance between high and good cardiovascular endurance in Test 3*

No significant differences were seen between academic performance and the following variables from Test 1, Test 2 and Test 3: body fat percentage (Table 4.5), flexibility (Table 4.6), muscle strength (Table 4.7) and muscle endurance (Table 4.8).

A statistically significant difference was observed in Test 3 when academic performance was compared to cardiovascular endurance ($p = 0,02$).

A possible explanation for the above results could be that many of the participants who enrol in BA (HMS) and B (SportSci) have a strong interest in an athletic career. This may lead to some students prioritising sports participation over academics which may have skewed the results in a similar fashion as shown above.

When comparing the categories of cardiovascular endurance and academic performance, there were statistically significant differences between the poor and low categories ($p = 0,04$), poor and good categories ($p = 0,007$), excellent and good categories ($p = 0,02$) and high to good categories ($p = 0,01$) (Table 4.9).

CHAPTER 5: SUMMARY

Owing to the pressure on students to perform academically, there has been a sharper focus on the role of physical activity in the academic environment. A quantitative approach was used to determine the objectives of the study. The study aimed to establish whether there was a strong and significant correlation ($p \leq 0,05$; $r \geq 0,61$) between the five health-related components of physical fitness and health status and academic performance. The secondary objective of the study was to determine the strength of the correlation between the AP score obtained in matric and the average academic score obtained in university. Understanding the relationship between physical fitness and academic performance is important for educators, policy makers and institutions in order to ensure that the right combination of policies and programmes are implemented.

Participants were tested on three separate occasions. The procedures and protocols are discussed in Chapter 3.

When determining whether significant differences ($p \leq 0,05$) existed between the measured variables and academic performance, the study yielded the following results:

- There was a strongly positive relationship ($p < 0,001$; $r = 0,55$) when comparing academic performance to AP score;
- There was a fairly negative relationship ($p = 0,02$; $r = -0,25$) when comparing academic performance to height;
- There was a fairly negative relationship ($p = < 0,001$; $r = -0,38$) when comparing academic performance to weight;
- There was a fairly negative relationship ($p = 0,02$; $r = -0,25$) when comparing academic performance to waist circumference;
- There was a fairly negative relationship ($p = 0,002$; $r = -0,33$) when comparing academic performance to hip circumference;
- There was a fairly negative relationship ($p = 0,03$; $r = -0,23$) when comparing academic performance to muscle strength;

- There was a fairly negative relationship ($p = 0,002$; $r = -0,33$) when comparing academic performance to BMI;
- There was a fairly positive relationship ($p = 0,007$; $r = 0,28$) when comparing academic performance to health status;
- A statistically significant difference was found in Test 3 when comparing academic performance to cardiovascular endurance ($p = 0,02$); and
- When comparing the categories of cardiovascular endurance to academic performance, there were statistically significant differences between the poor and low categories ($p = 0,04$), poor and good categories ($p = 0,007$), excellent and good categories ($p = 0,02$) and high to good categories ($p = 0,01$)

No significant differences were found between academic performance and the mean of the following variables: body fat percentage, waist/hip ratio, flexibility, muscle strength and muscle endurance. There was no statistical significance between the components of physical fitness and the health status questionnaire.

5.1. Limitations of present study

Certain limitations were present in this study. Firstly, to the researcher's knowledge, no studies relating the components of physical fitness to academic performance included adults in their sample group, which made it difficult to draw comparisons.

There was little variation in the level of mothers' education, the health status categories and the BMI scores of participants. With the majority of participants having normal BMI scores and selecting the healthy lifestyle category, results may have been skewed.

The mother's education did not appear to be an accurate reflection of SES. Sigfusdottir *et al.* (2007) reported a significant positive association between family structure and academic performance. Our findings could be more robust if information on family background had been included.

A problem inherent in measuring academic performance is the number of factors that could affect the results. Class attendance is a key measure of academic performance (Strong *et al.*, 2005; Benner & Graham, 2009) but was not included in

data collection. Other factors that may have had an influence on academic performance and were unaccounted for include classroom behaviour (Trudeau & Shephard, 2008), the amount of time spent preparing for class, the amount of time spent studying (Strydom & Mentz, 2010), television viewing (Borzekowski & Robinson, 2005; Hancox *et al.*, 2005; Shariff & Sargent, 2006) and nutrition (Kim *et al.*, 2003; Woodward, 2009). Thus, a complex web of environmental, financial and social factors makes it difficult to determine independent associations between fitness and academic achievement (Welk *et al.*, 2010).

A further limitation is the use of convenience sampling as it may limit the extent to which conclusions can be generalised across the population. The study sample was relatively small, which made it difficult to apply results to the general student population.

When comparing health status or academic performance to physical fitness, it is difficult to define physical fitness. It is an individualised concept that may differ from one person to the next.

5.2. Strengths of the research study

The components of physical fitness as well as academic performance were measured objectively. This adds extra strength to the present study as subjective measures can be biased and produce skewed results. Subjective measures make it difficult to compare outcomes (Sallis *et al.*, 1999; Van Dusen *et al.*, 2011). The present study controlled for SES which many studies failed to include. However, other variables such as parental support can influence these outcomes independently, so causality cannot be assumed.

5.3. Conclusions

Individual components of physical fitness do not appear to have a strong effect on academic performance or on health status; rather, the overall improvement in health status as a result of being physically fit is the determining factor. This is in agreement with the finding of Tremblay *et al.* (2000) who stated that physical activity may be indirectly related to enhanced academic performance by improving physical health

and self-esteem. Chomitz *et al.* (2009) agrees that physical fitness may reflect better health, and good health may contribute positively to academic performance.

Although improved cardiovascular endurance by itself will not improve academic performance, physical and other activities that promote good health may improve intellectual capacity. Universities should therefore incorporate comprehensive health promotion programmes in the university setting as they have the potential to add to population health and have a positive influence on educational achievement in university students. University students have less predictable daily routines to which regular exercise can be linked. To facilitate adherence to an exercise regime, students should make it a part of their daily routine, for example by going for walks with fellow students between classes. An effective way to change the health behaviours of university students is to teach them how to incorporate physical activity into their schedules.

5.4. Recommendations

The study aimed to establish the relationship between the components of physical fitness and academic performance. Although there was no significant relationship between academic performance and cardiovascular endurance, it is recommended that individuals improve their cardiovascular endurance as it increases the size of blood vessels, blood volume and cardiac dimensions. Cardiovascular endurance is also associated with a healthy heart, which in turn is related to health and according to this study health is related to academic performance.

Despite there being no significant relationship between academic performance and muscle strength, muscle endurance, body composition and flexibility, it is recommended that students participate in physical activity to improve the abovementioned components, as they are associated with numerous health benefits.

The study also aimed to establish the relationship between health status and academic performance. Owing to the positive association between these two components, it is recommended that students follow a healthy lifestyle as it may affect their academic performance positively and ultimately lead to securing employment in the future.

5.5. Recommendations for further research

Future studies should be conducted on university students to clarify the associations between physical fitness variables and academic performance in this particular age group.

Stronger associations with academic performance may be illustrated if more participants are classified in the highest and lowest BMI categories and in the poor and moderately healthy categories.

The accuracy of recording SES can be improved by using family structure, household income, or the educational level of both parents rather than only the mother's education level.

To limit confounding factors, future studies should incorporate data on factors such as time spent studying, time spent watching television, mental illness and nutrition.

It is recommended that a randomised sample be used in future. In respect of the study programme(s) of subjects, it is recommended that the same variables be investigated in other faculties and departments. BA (HMS) and B (SportSci) are very similar in content and structure and other academic programmes may have yielded different results.

It is recommended that a larger sample size be used in future studies.

As mentioned before, it is difficult to define physical fitness. Assigning a single score from the five components of physical fitness could serve as a recommendation for future studies.

Associations were found between physical fitness and academic scores in children and in adolescents. In the case of university students the association did not appear to be as strong. It can be recommended that future studies track the association between academic performance and the components of physical fitness from childhood to adulthood.

The majority of comparable studies are cross-sectional and correlational in design. It is recommended that controlled intervention studies be undertaken in future to isolate cause and effect.

REFERENCES

- Aberg, M.A., Pedersen, N.L., Torén, K., Svartengren, M., Bäckstrand, B., Johnsson, T., Cooper-Kuhn, C.M., Aberg, N.D., Nilsson, M. & Kuhn, H.G. (2009). Cardiovascular fitness is associated with cognition in young adulthood. ***Proceedings of the National Academy of Sciences of the United States of America***. 106(49):20906–20911.
- Acevedo, E.O. & Starks, M.A. (2003). ***Exercise Testing and Prescription Lab Manual***. USA: Human Kinetics.
- Adlaf, E.M., Gliksman, L., Demers, A. & Newton-Taylor, B. (2001). The prevalence of elevated psychological distress among Canadian undergraduates: findings from the 1998 Canadian Campus Survey. ***Journal of American College Health***. 50(2):67–72.
- Adler, N., Cohen, S., Cullen, M., McEwen, B., Paxson, C. & Schwartz, J. (2007). ***Reaching for a healthier life: Facts on socioeconomic status and health in the US***. USA: The John D and Catherine T. MacArthur Foundation.
- Ahamed, Y., Macdonald, H., Reed, K., Naylor, P.J., Liu-Ambrose, T. & McKay, H. (2007). School-based physical activity does not compromise children's academic performance. ***Medicine and Science in Sports and Exercise***. 39(2):371–376.
- Ainsworth, B.E. (2009). How do I measure physical activity in my patients? Questionnaires and objective methods. ***British Journal of Sports Medicine***. 43(1):6–9.
- Al-Isa, A.N., Cambell, J., Desapriya, E. & Wijesinghe, N. (2011). Social and health factors associated with physical activity among Kuwaiti college students. ***Journal of Obesity***. 2011:1–6.
- Allen, B. (1993). The student in higher education: nontraditional student retention. ***Catalyst***. 23(3):19–22.
- Allison, D.B. (1985). Antecedent exercise in the treatment of disruptive behavior: a meta-analytic review. ***Clinical Psychology: Science and Practice***. 2(3):279–303.
- Almond, L. & McGeorge, S. (1998). Physical activity and academic performance. ***British Journal of Physical Education***. 29(2):8–12.

Al-Nader, H.M., Al-Rhamnh, A.A. & Algafari, M.A. (2013). Psychological health of university student's practitioners of sport and its relationship with certain variables. ***European Scientific Journal***. 9(14):143–156.

Alonso-Alonso, M. & Pascual-Leone, A. (2007). The right brain hypothesis for obesity. ***Journal of the American Medical Association***. 297(16):1819–1822.

American College of Sports Medicine (ACSM). (2006). ***ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription (5th Edition)***. Baltimore, MD: Lippcott Williams & Wilkens.

American College of Sports Medicine (ACSM). (2010). ***ACSM's Guidelines for Exercise Prescription (8th Edition)***. Philadelphia, United States of America: Lippincott Williams and Wilkins.

Amponsah, M. & Owolabi, H.O. (2011). Perceived stress levels of fresh university students in Ghana: a case study. ***British Journal of Educational Research***. 1(2):153–169.

Ansari, W.E. & Stock, C. (2010). Is the health and well-being of university students associated with their academic performance? Cross-sectional findings from the United Kingdom. ***International Journal of Environmental Research and Public Health***. 7(2):509–527.

Ansari, W.E., Labeeb, S., Moseley, L., Kotb, S. & El-Houfy, A. (2013). Physical and psychological well-being of university students: survey of eleven faculties in Egypt. ***International Journal of Preventive Medicine***. 4(3):293–310.

Arnheim, D. & Prentice, W. (1993). ***Principles of Athletic Training, (8th Edition)***. St. Louis, Missouri: Mosby.

Astin, A.W. (2005). Making sense out of degree completion rates. ***Journal of College Student Retention Research Theory and Practice***. 7(1):5–17.

Aye, A.M., Chang, W.S., Amran, N., Ng, Y.Y., Lim, E.Y., Doustjalali, S.R., Al-Jashamy, K.A. & Pathak, R. (2013). Correlation between physical activity and memory functioning among university students. ***International Journal of Pharmacology and Toxicology Science***. 3(2):1–8.

Ayodele, C.S. & Adebisi, D.R. (2013). Study habits as influence of academic performance of university undergraduates in Nigeria. ***Research Journal in Organizational Psychology and Educational Studies***. 2(3):72–75.

Badat, S. (2010). ***The challenges of transformation in higher education and training institutes in South Africa***. South Africa: Development Bank of Southern Africa.

Baechle, T.R. & Earle, R.W. (2000). ***Essentials of Strength Training and Conditioning, (2nd Edition)***. Hong Kong: Human Kinetics.

Baechle, T.R. & Earle, R.W. (2008). ***Essentials of Strength Training and Conditioning, (3rd Edition)***. Hong Kong: Human Kinetics.

Baekeland, F. & Lasky, R. (1966). Exercise and sleep patterns in college athletes. ***Perceptual and Motor Skills***. 23(3):1203–1207.

Baltaci, G., Un, N., Tunay, V., Bresler, A. & Gerceker, S. (2003). Comparison of three different sit and reach tests for measurement of hamstring flexibility in female university students. ***British Journal of Sports Medicine***. 37(1):59–61.

Baranowski, R., Cullen, K.W., Basen-Engquist, K., Wetter, D.W., Cummings, S., Martineau, D.S., Prokhorov, A.V., Chorley, J., Beech, B. & Hergenroeder, A.C. (1997). Transitions out of high school: time of increased cancer risk. ***Preventive Medicine***. 26(5):694–703.

Barnes, D.E., Yaffe, K., Satariano, W.A. & Tager, I.B. (2003). A longitudinal study of cardiorespiratory fitness and cognitive function in healthy older adults. ***Journal of the American Geriatrics Society***. 51(4):459–465.

Bataineh, M.Z. (2013). Academic stress among undergraduate students: the case of education faculty at King Saud University. ***International Interdisciplinary Journal of Education***. 2(1):82–88.

Beck, R.A. “***Retention and dropout rates for a sample of National Higher Certificate students in the school of accounting***” (2011). *All Masters and Doctoral Theses and Dissertations*. <http://hdl.handle.net/10948/1408>.

Behr, A.L. (1985). The senior certificate examination as a predictor of university success. ***South African Journal of Education***. 5(1):107–112.

Belloc, N.B. & Breslow, L. (1972). The relation of physical health status and health practices. ***Preventive Medicine***. 1(3):409–421.

Bengtsson, B.A., Brummer, R.J., Edén, S., Rosén, T. & Sjöström, L. (1992). Effects of growth hormone on fat mass and fat distribution. ***Acta Paediatric Supplement***. 383(1):62–65.

Benner, A.D. & Graham, S. (2009). The transition to high school as a developmental process among multiethnic urban youth. ***Child development***. 80(2):356–376.

Biddle, S.J., Gorely, T. & Stensel, D.J. (2004). Health-enhancing physical activity and sedentary behavior in children and adolescents. ***Journal of Sport Sciences***. 22(8):679–701.

Binder, J.R., Desai, R.H., Graves, W.W. & Conant, L.L. (2009). Where is the semantic system? A critical review and meta-analysis of 120 functional neuroimaging studies. ***Cerebral Cortex***. 19(12):2767–2796.

Bisen, V. (2012). An assessment of stress among M.B.A. students: a study of selected colleges of G.B.T.U. in Lucknow (India). ***International Journal of Business and Management Tomorrow***. 2(2):1–7.

Black, J.E., Isaacs, K.R., Anderson, B.J., Alcantara, A.A. & Greenough, W.T. (1990). Learning causes synaptogenesis, whereas motor activity causes angiogenesis, in cerebellar cortex of adult rats. ***Proceedings of the National Academy of Sciences of the United States of America***. 87(14):5568–5572.

Black, J.E., Sirevaag, A.M. & Greenough, W.T. (1987). Complex experience promotes capillary formation in young rat visual cortex. ***Neuroscience Letters***. 83(3):351–355.

Blair, S.N., Jacobs, D.R. & Powell, K.E. (1985). Relationships between exercise or physical activity and other health behaviors. ***Public Health Reports***. 100(2):172–180.

Bleske, B.E., Erickson, S.R., Fahoum, S., Devarakonda, K.R., Welage, L.S., Koudmani, M., Pantham, N., Edwin, S.B., Devarakonda, S., Shea, M.J., Martha, S. & Khalidi, N. (2011). Cardiovascular risk among university students from developed and developing nations. ***The Open Cardiovascular Medicine Journal***. 5:117–122.

Bloemhoff, H.J. (2010). Gender and race related physical activity of students at a South African campus. ***African Journal for Physical, Health Education, Recreation and Dance***. 16(4):25–35.

Bluehardt, M.H., Wiener, J. & Shephard, R.J. (1995). Exercise programmes in the treatment of children with learning disabilities. ***Sports Medicine***. 19(1):55–72.

Blumenthal, J.A., Babyak, M.A., Moore, K.A., Craighead, W.E., Herman, S., Khatri, P., Waugh, R., Napolitano, M.A., Forman, L.M., Appelbaum, M., Doraiswamy, P.M. & Krishnan, K.R. (1999). Effects of exercise training on older patients with major depression. ***Archives of Internal Medicine***. 159(19):2349–2356.

Booth, F.W., Gordon, S.E., Carlson, C.J. & Hamilton, M.T. (2000). Waging war on modern chronic diseases: primary prevention through exercise biology. ***Journal of Applied Physiology***. 8(2):774–787.

Borse, L.J., Bansode, D.G., Yadav, R.D. & Modak, H.K. (2014). Relationship of waist to hip ratio and academic performance of first year medical college students. ***International Journal of Biological and Medical Research***. 5(3):4206–4212.

Borzekowski, D.L. & Robinson, T.N. (2005). The remote, the mouse, and the no. 2 pencil: the household media environment and academic achievement among third grade students. ***Archives of Pediatrics and Adolescent Medicine***. 159(7):607–613.

Bosco, J.S. (1983). ***Measurement and Evaluation in Physical Education, Fitness and Sport***. Englewood Cliffs, NJ: Prentice Hall.

Bradshaw, D., Steyn, K., Levitt, N. & Nojilana, B. (2011). ***Non-communicable diseases – a race against time***. University of Cape Town, South Africa: South African Medical Research Council.

Bray, S.R. & Born, H.A. (2004). Transition to university and vigorous physical activity: implications for health and psychological well-being. ***Journal of American College Health***. 52(4):181–188.

Breier, M. & Mabizela, M. (2008). Higher education. In: Kraak, A. & Press, K. (Eds.). ***Human resources development review 2008: Education, employment and skills in South Africa***. Cape Town: Human Sciences Research Council Press. 278–299.

Brown, R.S., Ramirez, D.E. & Taub, J.M. (1978). The prescription of exercise for depression. ***The Physician and Sportsmedicine***. 6(12):35–45.

Brunner, E. (1997). Socioeconomic determinants of health: stress and the biology of inequality. ***British Medical Journal***. 314(7092):1472–1476.

Buckworth, J. (2001). Exercise adherence in college students: issues and preliminary results. ***Quest***. 53(3):335–345.

Burton, L.J. & Van Heest, J.L. (2007). The importance of physical activity in closing the achievement gap. ***Quest***. 59(2):212–218.

Calfas, K.J. & Taylor, W.C. (1994). Effects of physical activity on psychological variables in adolescents. ***Pediatric Exercise Science***. 6(4):406–423.

Callender, J., Fagin, L., Jenkins, G., Lester, J., Smith, E., Baig, B., Blackwood, D., Day, R., Morriss, R. & Smith, D. (2011). ***Mental health of students in higher education: College report CR166***. London: Royal College of Psychiatrists.

Campos, A.L., Sigulem, D.M., Moraes, D.E. & Fisberg, M. (1996). Intelligent quotient of obese children and adolescents by the Weschler scale. ***Revista de Saúde Pública***. 30(1):85–90.

Carlson, S.A., Fulton, J.E., Lee, S.M., Maunard, L.M., Brown, D.R., Kohl, H.W. & Dietz, W.H. (2008). Physical education and academic achievement in elementary school: data from the early childhood longitudinal study. ***American Journal of Public Health***. 98(4):721–727.

Carroll, A., Houghton, S., Wood, R., Unsworth, K., Hattie, J., Gordon, L. & Bower, J. (2009). Self-efficacy and academic achievement in Australian high school students: the mediating effects of academic aspirations and delinquency. ***Journal of Adolescence***. 32(4):797–817.

Caspersen, C.J., Powell, K.E. & Christenson, G.M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. ***Public Health Reports***. 100(2):126–131.

Castelli, D.M., Hillman, C.H., Buck, S.M. & Erwin, H.E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. ***Journal of Sport and Exercise Psychology***. 29(2):239–252.

Caterino, M.C. & Polak, E.D. (1999). Effects of two types of activity on the performance of second-, third-, and fourth-grade students on a test of concentration. ***Perceptual and Motor Skills***. 89(1):245–248.

Chang, Y.K., Labban, J.D., Gapin, J.L. & Etnier, J.L. (2012). The effects of acute exercise on cognitive performance: a meta-analysis. ***Brain Research***. 1453:87–101.

Central University of Technology, Free State. ***General admission requirements***. (<http://www.cut.ac.za/admission/>). Retrieved 25 July 2015.

Cherif, A.H. & Wideen, M.F. (1992). The problems of the transition from high school to university science. ***Catalyst***. 36(1):10–18.

Chomitz, V.R., Slining, M.M., McGowan, R.J., Mitchell, S.E., Dawson, G.F. & Hacker, K.A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. ***Journal of School Health***. 79(1):30–37.

Churchill, J.D., Galvez, R., Colcombe, S., Swain, R.A., Kramer, A.F. & Greenough, W.T. (2002). Exercise, experience, and the aging brain. ***Neurobiology of Aging***. 23(5):941–955.

Chýlová, H. & Natovová, L. (2012). Stress coping strategies at university students – Part 1: gender differences. ***Journal on Efficiency and Responsibility in Education and Science***. 5(3):135–147.

Cignano, F. & Cipollone, P. (2003). ***Determinants of University drop-out probability in Italy***. Rome, Italy: Bank of Italy, Research Department.

Coe, D.P., Pivarnik, J.M., Womack, C.J., Reeves, M.J. & Malina, R.M. (2006). Effect of physical education and activity levels on academic achievement in children. ***Medicine and Science in Sports and Exercise***. 38(8):1515–1519.

Coelho, F.M., Pereira, D.S., Lustosa, L.P., Silva, J.P., Dias, J.M., Dias, R.C., Queiroz, B.Z., Teixeira, A.L., Teixeira, M.M. & Pereira, L.S. (2012). Physical therapy intervention (PTI) increases plasma brain-derived neurotrophic factor (BDNF) levels in non-frail and pre-frail elderly women. ***Archives of Gerontology and Geriatrics***. 54(3):415–420.

Colcombe, S. & Kramer, A.F. (2003). Fitness effects on the cognitive function of older adults: a meta-analytic study. ***Psychological Science***. 14(2):125–130.

Colcombe, S. J., Erickson, K.I., Raz, N., Webb, A.G., Cohen, N.J., McAuley, E. & Kramer, A.F. (2003). Aerobic fitness reduces brain tissue loss in aging humans. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*. 58(2):176–180.

Colcombe, S. J., Erickson, K.I., Scalf, P.E., Prakash, R., McAuley, E., Elavsky, S., Marguez, D.X., Hu, L. & Kramer, A.F. (2006). Aerobic exercise training increases brain volume in aging humans. ***The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences***. 61(11):1166–1170.

Colcombe, S.J., Kramer, A.F., Erickson, K.I., Scalf, P., McAuley, E., Cohen, N.J., Webb, A., Jerome, G.J., Marguez, D.X. & Elavsky, S. (2004). Cardiovascular fitness, cortical plasticity, and aging. ***Proceedings of the National Academy of Sciences of the United States of America***. 101(9):3316–3321.

Considine, G. & Zappalá, G. (2002). ***Factors influencing the educational performance of students from disadvantaged backgrounds***. University of New South Wales, Sydney: SPRC Report.

Cooper, H., Valentine, J.C., Nye, B. & Lindsay, J.J. (1999). Relationship between five after-school activities and academic achievement. ***Journal of Educational Psychology***. 91(2):369–378.

Cotman, C.W. & Berchtold, N.C. (2002). Exercise: a behavioral intervention to enhance brain health and plasticity. ***Trends in Neurosciences***. 25(6):295–301.

Cottrell, L.A., Northrup, K. & Wittberg, R. (2007). The extended relationship between child cardiovascular risks and academic performance measures. ***Obesity***. 15(12):3170–3177.

Council on Higher Education. (2000). ***Towards a new higher education landscape: meeting the equity, quality and social development imperatives of South Africa in the 21st century***. Pretoria: Council on Higher Education.

Council on Higher Education. (2009). ***Higher Education Monitor no.8: The State of Higher Education in South Africa***. Pretoria: Council on Higher Education.

Cowan, R.E. & Nash, M.S. (2010). Cardiovascular disease, SCI and exercise: unique risks and focused countermeasures. ***Disability and Rehabilitation***. 32(26):2228–2236.

Creighton, L.M. (2007). Factors affecting the graduation rates of university students from underrepresented populations. ***International Electronic Journal for Leadership in Learning***. 11(7):1–12.

Çuhadar, S., Atay, A., Sağlam, G., Köseoğlu, M. & Çuhadar, L. (2013). Cardiovascular risk factors in young male adults: impact of physical activity and parental education. ***Central Asian Journal of Global Health***. 2(1):1–11.

Cupples, S.A. & Stilley, C.S. (2005). Cognitive function in adult cardiothoracic transplant candidates and recipients. ***The Journal of Cardiovascular Nursing***. 20(5):74–87.

D'Hombres, B. (2007). *The impact of university reforms on dropout rates and students' status: evidence from Italy*. Luxemburg: Retrieved 15 February 2015. <<http://crell.jrc.ec.europa.eu/Publications/CRELL%20Research%20Papers/The%20impact%20of%20university%20reforms%20on%20dropout%20rates.pdf>>.

Daniel, S.S., Walsh, A.K., Goldston, D.B., Arnold, E.M., Reboussin, B.A. & Wood, F.B. (2006). Suicidality, school drop-out, and reading problems among adolescents. ***Journal of Learning Disabilities***. 39(6):507–514.

Datar, A. & Sturm, R. (2006). Childhood overweight and elementary school outcomes. ***International Journal of Obesity***. 30(9):1449–1460.

Davenport, M.N., Hogan, D.B., Eskes, G.A., Longman, R.S. & Poulin, M.J. (2012). Cerebrovascular reserve: the link between fitness and cognitive function. ***Exercise and Sport Sciences Reviews***. 40(3):153–158.

Davis, C.L., Tomporowski, P.D., Boyle, C.A., Waller, J.L., Miller, P.H., Naglieri, J.A. & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: a randomized controlled trial. ***Research Quarterly for Exercise and Sport***. 78(5):510–519.

Davis-Kean, P.E. (2005). The influence of parent education and family income on child achievement: the indirect role of parental expectations and the home environment. ***Journal of Family Psychology***. 19(2):294–304.

Davranche, K. & Audiffren, M. (2004). Facilitating effects of exercise on information processing. ***Journal of Sports Sciences***. 22(5):419–428.

Davranche, K., Hall, B. & McMorris, T. (2009). Effect of acute exercise on cognitive control required during an Eriksen Flanker Task. ***Journal of Sport and Exercise Psychology***. 31(5):628–639.

DeFreitas, S.C. & Rinn, A. (2013). Academic achievement in first generation college students: the role of academic self-concept. ***Journal of the Scholarship of Teaching and Learning***. 13(1):57–67.

Department of Basic Education. (2011). ***Report on dropout and learner retention strategy to portfolio committee on education***. Pretoria: Department of Basic Education.

Department of Education. (1997). ***Education White Paper 3: a programme for the transformation of higher education***. Pretoria: Department of Education.

Department of Education. (2005). ***Student enrolment planning in public higher education***. Pretoria: Department of Education.

Department of Health. (2007). ***South Africa demographic and health survey 2003: full report***. Pretoria: Medical Research Council.

Department of Labour. (2007). ***National master scarce skills list for South Africa***. Pretoria: Department of Labour.

Dik, M.G., Deeg, D.J.H., Visser, M. & Jonker, C. (2003). Early life physical activity and cognition at old age. ***Journal of Clinical and Experimental Neuropsychology***. 25(5):643–653.

Dimeo, F., Bauer, M., Varahram, I., Proest, G. & Halter, U. (2001). Benefits from aerobic exercise in patients with major depression: a pilot study. ***British Journal of Sports Medicine***. 35(2):114–117.

Dishman, R.K., Berthoud, H., Booth, F.W., Cotman, C.W., Edgerton, V.R., Fleshner, M.R., Gadevia, S.C., Gomez-Pinilla, F., Greenwood, B.N., Hillman, C.H., Kramer, A.F., Levin, B.E., Moran, T.H., Russo-Neustadt, A.A., Salamone, J.D., Van Hoomissen, J.D., Wade, C.E., York, D.A. & Zigmond, M.J. (2006). ***Neurobiology of Exercise. Obesity***. 14(3):345–356.

Dorland, W.A.N. (1974). ***Dorland's Illustrated Medical Dictionary (25th Edition)***. Philadelphia: Saunders.

Douglas, K.A., Collins, J.L., Warren, C., Kann, L., Gold, R., Clayton, S., Ross, J.G. & Kolbe, L.J. (1997). Results from the 1995 National College health risk behavior survey. ***Journal of American College Health***. 46(2):55–67.

Driver, H.S. & Taylor, S.R. (2000). Exercise and sleep. ***Sleep Medicine Reviews***. 4(4):387–402.

Du Plessis, A., Müller, H. & Prinsloo, P. (2005). Determining the profile of the successful first year accounting student. ***South African Journal of Higher Education***. 19(4):684–698.

Du Toit, D., Pienaar, A.E. & Truter, L. (2011). Relationship between physical fitness and academic performance in South African children. ***South African Journal for Research in Sport, Physical Education and Recreation***. 33(3):23–35.

Duncan, J., Emslie, H., Williams, P., Johnson, R. & Freer, C. (1996). Intelligence and the frontal lobe: the organization of goal directed behavior. ***Cognitive Psychology***. 30(3):257–303.

Dunn, A.L., Trivedi, M.H., Kampert, J.B., Clark, C.G. & Chambliss, H.O. (2005). Exercise treatment for depression: efficacy and dose response. ***American Journal of Preventive Medicine***. 28(1):1–8.

Dwyer, T., Coonan, W.E., Leitch, D.R., Hetzel, B.S. & Baghurst, R.A. (1983). An investigation on the effects of daily physical activity on the health of primary school students in South Australia. ***International Journal of Epidemiology***. 12(3):308–313.

Dwyer, T., Sallis, J.F., Blizzard, L., Lazarus, R. & Dean, K. (2001). Relation of academic performance to physical activity and fitness in children. ***Pediatric Exercise Science***. 13(3):225–237.

Eduoloan. *South Africa's high university dropout rates* (online). 2009. Available from <http://www.moneyweb.co.za/mw/view/mw/en/page62093?oid=2808128&sn=Detail/> (accessed: 1 February 2015).

Eisenberg, D., Gollust, S.E., Gollerstein, E. & Hefner, J.L. (2007). Prevalence and correlates of depression, anxiety, and suicidality among university students. ***American Journal of Orthopsychiatry***. 77(4):534–542.

Ekeland, E., Heian, F., Hagen, K.B., Abbott, J. & Nordheim, L. (2004). ***Exercise to improve self-esteem in children and young people: review***. Bergen: John Wiley & Sons.

Enslin, P. & Pendlebury, S. (1998). Transforming education in South Africa? ***Cambridge Journal of Education***. 28(3):261–267.

Erickson, K.I., Voss, M.W., Prakash, R.S., Basak, C., Szabo, A., Chaddock, L., Kim, J.S., Heo, S., Alves, H., White, S.M., Wojcicki, T.R., Mailey, E., Vieira, V.J., Martin, S.A., Pence, B.D., Woods, J.A., McAuley, E. & Kramer, A.F. (2011). Exercise training increases size of hippocampus and improves memory. ***Proceedings of the National Academy of Sciences of the United States of America***. 108(7):3017–3022.

Eston, R. & Reilly, T. (1996). ***Kinanthropometry and Exercise Physiology Laboratory Manual***. London: E & FN Spon.

Etnier, J.L., Nowell, P.M., Landers, D.M. & Sibley, B.A. (2006). A meta-regression to examine the relationship between aerobic fitness and cognitive performance. ***Brain Research Reviews***. 52(1):119–130.

Etnier, J.L., Salazar, W., Landers, D.M., Petruzzello, S.J., Han, M. & Nowell, P. (1997). The influence of physical fitness and exercise upon cognitive functioning: a meta-analysis. ***Journal of Sport and Exercise Psychology***. 19(3):249–277.

Evans, G.W. (2004). The environment of childhood poverty. ***American Psychologist***. 59(2):77–92.

Eveland-Sayers, B.M., Farley, R.S., Fuller, D.K., Morgan, D.W. & Caputo, J.L. (2009). Physical fitness and academic achievement in elementary school children. ***Journal of Physical Activity and Health***. 6(1):99–104.

Farooq, M.S., Chaudhry, A.H., Shafiq, M. & Berhanu, G. (2011). Factors affecting students' quality of academic performance: a case of secondary school level. ***Journal of Quality and Technology Management***. 7(2):1–14.

Ferrara, C.M. (2009). The college experience: physical activity, nutrition, and implications for intervention and future research. ***Journal of Exercise Physiologyonline***. 12(1):23–35.

Fleshner, M. (2000). Exercise and neuroendocrine regulation of antibody production: protective effect of physical activity on stress-induced suppression of the specific antibody response. ***International Journal of Sports Medicine***. 21(1):14–19.

Flook, L., Repetti, R.L. & Ullman. (2005). Classroom social experiences as predictors of academic performance. ***American Psychological Association***. 41(2):319–327.

Folkins, C.H., Lynch, S. & Gardner, M.M. (1972). Psychological fitness as a function of physical fitness. ***Archives of Physical Medicine and Rehabilitation***. 53(11):503–508.

Fountaine, C., Liguori, G.A., Mozumdar, A. & Schuna, J.M. (2011). Physical activity and screen time sedentary behaviors in college students. ***International Journal of Exercise Science***. 4(2):102–112.

Fox, E., Bowers, R. & Foss, M. (1993). ***The Physiological Basis for Exercise and Sport (5th Edition)***. Dubuque: Brown and Benchmark.

Fox, K.R. (1999). The influence of physical activity on mental well-being. ***Public Health Nutrition***. 2(3a):411–418.

Fraser, W.J. & Killen, R. (2003). Factors influencing academic success or failure of first-year and senior university students: do education students and lecturers perceive things differently. ***South African Journal of Education***. 23(4):254–260.

Gallery, M. (2002). Texas requires elementary schools to offer 2-plus hours of physical education. ***Education Week***. 21(29):10–13.

Garcia, A.W., Pender, N.J., Antonakos, C.L. & Ronis, D.L. (1998). Changes in physical activity beliefs and behaviors of boys and girls across the transition to junior high school. ***Journal of Adolescent Health***. 22(5):394–402.

Gilbert, S. & Weaver, C.C. (2010). Sleep quality and academic performance in university students: a wake-up call for college psychologists. ***Journal of College Student Psychotherapy***. 24(4):295–306.

Goldwater, B.C. & Collis, M.L. (1985). Psychologic effects of cardiovascular conditioning: a controlled experiment. *Psychosomatic Medicine*. 47(2):174–181.

Grais, B.M. “**High school transfer student transitions and changes: risk, success, failure, and the vital role of the counseling curriculum**” (2011). *Dissertations*. Paper 66. http://ecommons.luc.edu/luc_diss/66.

Greenough, W.T. & Black, J.E. (1992). Induction of brain structure by experience: substrates for cognitive development. In: Gunnar, M.R. & Nelson, C.A. (Eds.). *Developmental Behavioural Neuroscience*. (Minnesota Symposia on Child Psychology). Hillsdale: Erlbaum. 155–200.

Grissom, J.B. (2005). Physical fitness and academic achievement. *Pediatric Exercise Science*. 8(1):11–25.

Grunbaum, J., Kann, L., Kinchen, S. A., Williams, B., Ross, J.G., Lowry, R. & Kolby, L. (2002). Youth risk behavior surveillance – United States 2001. *Journal of School Health*. 72(8):313–328.

Gyurcsik, N.C., Spink, K.S., Bray, S.R., Chad, K. & Kwan, M. (2006). An ecologically based examination of barriers to physical activity in students from grade seven through first-year university. *Journal of Adolescent Health*. 38(6):701–711.

Haase, A., Steptoe, A., Sallis, J.F. & Wardle, J. (2004). Leisure-time physical activity in university students from 23 countries: associations with health beliefs, risk awareness, and national economic development. *Preventive Medicine*. 39(1):182–190.

Hagedorn, L.S. (2009). *How to define retention: a new look at an old problem*. Los Angeles, California: Transfer and Retention of Urban Community College Students Project.

Hajian-Tilaki, K.O. & Heidari, B. (2006). Prevalence of obesity, central obesity and the associated factors in urban population aged 20–70 years, in the north of Iran: a population-based study and regression approach. *Obesity Reviews*. 8(1):3–10.

Hall, E. (2007). Integration: Helping to get our kids moving and learning. *Physical Educator*. 64(3):123–128.

Hall, J.C. (2001). *Retention and wastage in FE and HE*: The Scottish Council for Research in Education, 9.

Hancox, R.J., Milne, B.J. & Poulton, R. (2005). Association of television viewing during childhood with poor educational achievement. ***Archives of Pediatrics and Adolescent Medicine***. 159(7):614–618.

Hausenblas, H.A. & Symons Downs, D. (2001). Comparison of body image between athletes and non-athletes: a meta-analytic review. ***Journal of Applied Sport Psychology***. 13(3):323–339.

Herholz, K., Buskies, W., Rist, M., Pawlik, G., Hollmann, W. & Heiss, W.D. (1987). Regional cerebral blood flow in men at rest and during exercise. ***Journal of Neurology***. 234(1):9–13.

Heyn, P., Abreu, B.C. & Ottenbacher, K.J. (2004). The effects of exercise training on elderly persons with cognitive impairment and dementia: a meta-analysis. ***Archives of Physical Medicine and Rehabilitation***. 85(10):1694–1704.

Heyward, V. (2006). ***Advanced Fitness Assessment and Exercise Prescription, (5th Edition)***. Illinois: Human Kinetics.

Hicks, T. & Heastie, S. (2008). High school to college transition: a profile of the stressors, physical and psychological health issues that affect the first-year on-campus college student. ***Journal of Cultural Diversity***. 15(3):143–147.

Hillman, C.H., Castelli, D.M. & Buck, S.M. (2005). Aerobic fitness and neurocognitive function in healthy preadolescent children. ***Official Journal of the American College of Sports Medicine***. 37(11):1–8.

Hillman, C.H., Erickson, K.I. & Kramer, A.F. (2008). Be smart, exercise your heart: exercise effects on brain and cognition. ***Nature Reviews Neuroscience***. 9(1):58–65.

Hoffman, J. (2006). ***Norms for Fitness, Performance, and Health***. USA: Human Kinetics.

<http://www.sanusihasiswa.com/2012/03/harvard-step-test-tes-ini-adalah.html>.

Retrieved 15 January 2015.

Huang, T., Ried-Larsen, M., Moller, N.C. & Andersen, L.B. (2013). The effects of physical activity and exercise on brain-derived neurotrophic factor in healthy humans: a review. ***Scandinavian Journal of Medicine and Science in Sports***. 24(1):1–10.

Irwin, J. D. (2007). The prevalence of physical activity maintenance in a sample of university students: a longitudinal study. ***Journal of American College Health***. 56(1):37–41.

Isaac, V., Sim, S., Zheng, H., Zagorodnov, V., Tai, E.S. & Chee, M. (2011). Adverse associations between visceral adiposity brain structure, and cognitive performance in healthy elderly. **Front Aging Neuroscience**. 3(1):1–12.

Jawitz, J. (1995). Performance in first- and second- year engineering at the University of Cape Town. **South African Journal of Higher Education**. 9(1):101–108.

Jensen, E. (1998). **Teaching with the brain in mind**. Virginia, United States of America: Association for Supervision and Curriculum Development.

Judge, S. & Jahns, L. (2007). Association of overweight with academic performance and social and behavioral problems: an update from the early childhood longitudinal study. **The Journal of School Health**. 77(10):672–680.

Jurca, R., Jackson, A.S., LaMonte, M.J., Morrow, J.R., Blair, S.N., Wareham, N.J., Haskell, W.L., van Mechelen, W., Church, T.S., Jakicic, J.M. & Laukkanen, R. (2005). Assessing cardiorespiratory fitness without performing exercise testing. **American Journal of Preventive Medicine**. 29(3):185–193.

Kadapatti, M. & Vijayalaxmi, A.H.M. (2012). Stressors of academic stress – a study on pre-university students. **Indian Journal of Scientific Research**. 3(1):171–175.

Keating, X.D., Guan, J., Pinero, J.C. & Bridges, D.M. (2005). A meta-analysis of college students' physical activity behaviors. **Journal of American College Health**. 54(2):116–125.

Keays, J.J. & Allison, K.R. (1995). The effects of regular moderate to vigorous physical activity on student outcomes: a review. **Canadian Journal of Public Health**. 86(1):62–65.

Keeley, T.J.H. & Fox, K.R. (2009). The impact of physical activity and fitness on academic achievement and cognitive performance in children. **International Review of Sport and Exercise Psychology**. 2(2):198–214.

Kelder, S.H., Perry, C.L., Klepp, K.I. & Lytle, L.L. (1994). Longitudinal tracking of adolescent smoking, physical activity, and food choice behaviors. **American Journal of Public Health**. 84(7):1121–1126.

Keller, S., Maddock, J.E., Hannöver, W., Thyrian, J.R. & Basler, H.D. (2008). Multiple risk behaviors in German first year students. **Preventive Medicine**. 46(3):189–195.

Kemoun, G., Thibaud, M., Roumagne, N., Carette, P., Albinet, C., Toussaint, L., Paccalin, M. & Dugué, B. (2010). Effects of physical training programme on cognitive function and walking efficiency in elderly persons with dementia. ***Dementia and Geriatric Cognitive Disorders***. 29(2):109–114.

Kempermann, G., Kuhn, H.G. & Gage, F.H. (1997). More hippocampal neurons in adult mice living in an enriched environment. ***Nature***. 386(6624):493–495.

Kempermann, G., Kuhn, H.G. & Gage, F.H. (1998). Experience-induced neurogenesis in the senescent dentate gyrus. ***The Journal of Neuroscience***. 18(9):3206–3212.

Khan, I.S., Rahman, M.A. & Amin, R. (2011). Study of ECG changes in apparently healthy adult male smokers. ***Dinajpur Medical College Journal***. 4(1):7–14.

Khashayar, P., Heshmat, R., Qorbani, M., Motlagh, M.E., Aminaee, T., Ardalan, G., Farrokhi-Khajeh-Pasha, Y., Taslimi, M., Larijani, B. & Kelishadi, R. (2013). Metabolic syndrome and cardiovascular risk factors in a national sample of adolescent population in the Middle East and North Africa: the CASPIAN III study. ***International Journal of Endocrinology***. 2013:1–8.

Kilpatrick, M., Herbert, E. & Bartholomew, J. (2005). College students' motivation for physical activity: differentiating men's and women's motives for sport participation and exercise. ***Journal of American College Health***. 54(2):87–94.

Kim, H.Y., Frongillo, E.A., Hans, S.S., Oh, S.Y., Kim, W.K., Jang, Y.A., Won, H.S., Lee, H.S. & Kim, S.H. (2003). Academic performance of Korean children is associated with dietary behaviours and physical status. ***Asia Pacific Journal of Clinical Nutrition***. 12(2):186–192.

Kraak, A., Lauder, H., Brown, P. & Ashton, D. (2006). ***Debating high skills and joined up policy***. Cape Town: Human Sciences Research Council.

Kramer, A.F., Colcombe, S., Erickson, K., Belopolsky, A., McAuley, E., Cohen, N.J., Webb, A., Jerome, G.J., Marquez, D.X. & Wszalek, T.M. (2002). Effects of aerobic fitness training on human cortical function. ***Journal of Molecular Neuroscience***. 19(1–2):227–231.

Kramer, A.F., Erickson, K.I. & Colcombe, S. J. (2006). Exercise, cognition, and the aging brain. ***Journal of Applied Physiology***. 101(4):1237–1242.

Kramer, A.F., Hahn, S., Cohen, N.J., Banich, M.T., McAuley, E., Harrison, C.R., Chason, J., Vakil, E., Vardell, L., Boileau, R.A. & Colcombe, A. (1999). Ageing, fitness, and neurocognitive function. ***Nature***. 400(6743):418–419.

Krüger, P.E. & Van Vuuren, B. (2000). ***Laboratoriumhandleiding vir die endossemente Biokinetika en Sportkunde***, Instituut vir Sportnavorsing, Universiteit van Pretoria: 1–198,

Kuh, G.D., Kinze, J., Buckley, J.A., Bridges, B.K. & Hayek, J.C. (2007). ***Piecing together the student success puzzle: research, propositions and recommendations***. San Francisco: Jossey-Bass.

Kuh, G.D., Kinze, J., Shuh, J.H. & Witt, E.J. (2005). ***Student success in college: creating conditions that matter***. San Francisco: Jossey-Bass.

Kwak, L., Kremers, S.P., Bergman, P., Ruiz, J.R., Rizzo, N.S. & Sjöström, M. (2009). Associations between physical activity, fitness, and academic achievement. ***The Journal of Pediatrics***. 155(6):914–918.

Lambourne, K. (2006). The relationship between working memory capacity and physical activity rates in young adults. ***Journal of Sports Science and Medicine***. 5(1):149–153.

Landis, J. & Koch, G. (1977). The measurement of observer agreement for categorical data. ***Biometrics***. 33(1):159–174.

Laurin, D., Verreault, R., Lindsay, J., MacPherson, K. & Rockwood, K. (2001). Physical activity and risk of cognitive impairment and dementia in elderly persons. ***Archives of Neurology***. 58(3):498–504.

Leslie, E., Sparling, P.B. & Owen, N. (2001). University campus settings and the promotion of physical activity in young adults: lessons from research in Australia and the USA. ***Health Education***. 101(3):116–125.

Letseka, M. & Cosser, M. (2009). ***Pathways through higher education to the labour market: student retention, graduation and destination***. Pretoria: Human Sciences Research Council.

Letseka, M. & Maile, S. (2008). ***High university drop-out rates: a threat to South Africa's future***. Pretoria: Human Sciences Research Council.

Letseka, M. (2009). ***University drop-out and researching (lifelong) learning and work***. Cape Town: Human Sciences Research Council.

Li, Y., Dai, Q., Jackson, J.C. & Zhang, J. (2008). Overweight is associated with decreased cognitive functioning among school-age children and adolescents. ***Obesity***. 16(8):1809–1815.

Liao, P., Chang, H., Wang, J. & Wu, M. (2013). Physical fitness and academic achievement performance: empirical evidence from the national administrative senior high school student data in Taiwan. **Health Education Research**. 28(3):512–522.

Lichtman, S. & Poser, E.G. (1983). The effects of exercise on mood and cognitive functioning. **Journal of Psychosomatic Research**. 27(1):43–52.

Lindwall, M., Ljung, T., Hadzibajramovic, E. & Jonsdottir, I.H. (2012). Self-reported physical activity and aerobic fitness are differently related to mental health. **Mental Health and Physical Activity**. 5(1):28–34.

Lizzio, A., Wilson, K. & Simons, R. (2002). University students' perceptions of the learning environment and academic outcomes: implications for theory and practice. **Studies in Higher Education**. 27(1):27–52.

López-Miñarro, P.A., Sáinz de Baranda Andújar, P. & Rodríguez-García, P.L. (2009). A comparison of the sit-and-reach test and the back-saver sit-and-reach test in university students. **Journal of Sports Science and Medicine**. 8(1):116–122.

Lou, S.J., Liu, J.Y., Chang, H. & Chen, P.J. (2008). Hippocampal neurogenesis and gene expression depend on exercise intensity in juvenile rats. **Brain Research**. 1210:48–55.

Lovell, G.P., Ansari, W.E. & Parker, J.K. (2010). Perceived exercise benefits and barriers of non-exercising female university students in the United Kingdom. **International Journal of Environmental Research and Public Health**. 7(3):784–798.

Lyrakos, D.G. (2012). The impact of stress, social support, self-efficacy and coping on university students, a multicultural European study. **Psychology**. 3(2):143–149.

MacAuley, D. (2007). **Oxford Handbook of Sport and Exercise Medicine**. Oxford: Oxford University Press.

Mailey, E.L., White, S.M., Wojcicki, T.R., Kramer, A.F. & McAuley, E. (2010). Construct validation of a non-exercise measure of cardiorespiratory fitness in older adults. **BMC Public Health**. 10(59):1–8.

Malina, R.M. (2001). Adherence to physical activity from childhood to adulthood: a perspective from tracking studies. **Quest**. 53(3):346–355.

Maree, K. (2008). The story of changing education realities in the 21st century: familiar themes, same relevance! (editorial introduction). ***Perspectives in Education***. 26(4):1–5.

Marfell-Jones, M., Olds, T., Stewart, A. & Carter, L. (2006). ***International Standards for Anthropometric Assessment***. Potchefstroom: International Society for the Advancement of Kinanthropometry.

Martinez, P. & Munday, F. (1998). ***9,000 voices: student persistence and drop-out in further education***. London: Further Education Development Agency.

Martinez, P. (2001). ***Improving student retention and achievement: what do we know and what do we need to find out***. London: Learning and Skills Development Agency.

Matsumoto, Y., Toyomasu, K. & Uchimura, N. (2011). Assessment of physical and mental health in male university students with varying sleep habits. ***Kurume Medical Journal***. 58(4):105–115.

McAuley, E., Courneya, K.S., Rudolph, D.L. & Lox, C.L. (1994). Enhancing exercise adherence in middle-aged males and females. ***Preventive Medicine***. 23(4):498–506.

McLeroy, K.R., Bibeau, D., Steckler, A. & Glanz, K. (1988). An ecological perspective on health promotion programs. ***Health Education Quarterly***. 15(4):351–377.

Mendonca, G.V., Pereira, F.D. & Fernhall, B. (2011). Effects of cigarette smoking on cardiac autonomic function during dynamic exercise. ***Journal of Sports Sciences***. 29(9):879–886.

Meyer, J.H.F., Parsons, P. & Dunne, T.T. (1990). Individual study orchestrations and their association with learning outcome. ***Higher Education***. 20(1):67–89.

Miller, D.I., Taler, V., Davidson, P.S.R. & Messier, C. (2012). Measuring the impact on cognitive aging: methodological issues. ***Neurobiology of Aging***. 33(3):622.e29–622.e43.

Miller, D.K. (1994). ***Measurement by the Physical Educator: Why and how, (2nd Edition)***. North Carolina: Brown and Benchmark.

Ministry of Education. (2001). ***Draft national plan for higher education in South Africa***. Pretoria: Ministry of Education.

Misra, R. & Castillo, L.G. (2004). Academic stress among college students: comparison of American and international students. ***International Journal of Stress Management***. 11(2):132–148.

Mokdad, A.H., Marks, J.S., Stroup, D.F. & Gerberding, J.L. (2004). Actual causes of death in the United States. ***Journal of the American Medical Association***. 291(10):1238–1245.

Mortmer, J.A., Ding, D., Borenstein, A.R., DeCarli, C., Wu, Y., Zhao, Q. & Chu, S. (2012). Changes in brain volume and cognition in a randomized trial of exercise and social interaction in a community-based sample of non-demented Chinese elders. ***Journal of Alzheimer's Disease***. 30(4):757–766.

Moses, J., Steptoe, A., Mathews, A. & Edwards, S. (2004). The effects of exercise training on mental well-being in the normal population: a controlled trial. ***Journal of Psychosomatic Research***. 33(1):47–61.

Mouton, N., Louw, G.P. & Strydom, G.L. (2013). Present-day dilemmas and challenges of the South African Tertiary system. ***International Business & Economics Research Journal***. 12(3):285–300.

Mujović, V.M. & Čubrilo, D. (2012). The role of physical activity in the prevention and treatment of diseases. ***Physical Culture***. 66(1):40–47.

Mushtaq, I. & Khan, S.N. (2012). Factors affecting students' academic performance. ***Global Journal of Management and Business Research***. 12(9):17–22.

Neeper, S.A., Gomez-Pinilla, F., Choi, J. & Cotman, C.W. (1996). Physical activity increases mRNA for brain-derived neurotrophic factor and nerve growth factor in rat brain. ***Brain Research***. 726(1–2):49–56.

Nelson, C.A. (1999). Neural plasticity and human development. ***Current Directions in Psychological Science***. 8(2):42–45.

Nelson, M.C. & Gordon-Larsen, P. (2006). Physical activity and sedentary behavior patterns are associated with selected adolescent health risk behaviors. ***Pediatrics***. 117(4):1281–1290.

Nelson Mandela Metropolitan University. ***APS calculator***. (<https://www.nmmu.ac.za/Apply/Admission/APS-Calculator>). Retrieved 25 July 2015.

Nieman, D. (2003). ***Exercise Testing and Prescription: A Health-Related Approach***. Montana: McGraw Hill.

Odaci, H. & Çikrikçi, Ö. (2012). University students' ways of coping with stress, life satisfaction and subjective well-being. ***The Online Journal of Counseling and Education***. 1(3):118–131.

Ogude, N., Kilfoil, W. & du Plessis, G. (2012). An institutional model for improving student retention and success at the University of Pretoria. ***The International Journal of the First Year in Higher Education***. 3(1):21–34.

Palmore, E. (1970). Health practices and illness among the aged. ***The Gerontologist***. 10(4):313–316.

Pastula, R.M., Stopka, C.B., Delisle, A.T. & Hass, C.J. (2012). Effect of moderate-intensity exercise training on the cognitive function of young adults with intellectual disabilities. ***Journal of Strength and Conditioning Research***. 26(12):3441–3448.

Pate, R.R., Heath, G.W., Dowda, M. & Trost, S.G. (1996). Associations between physical activity and other health behaviors in a representative sample of US adolescents. ***American Journal of Public Health***. 86(11):1577–1581.

Pate, R.R., Long, B.J. & Heath, G.W. (1994). Descriptive epidemiology of physical activity in adolescents. ***Pediatric Exercise Science***. 6(4):434–447.

Pathrudu, G.B. (2015). Waist hip ratio is negatively associated with academic performance of students. ***International Journal of Health Research in Modern Integrated Medical Sciences***. 2(1):13–16.

Pereira, A.C., Huddleston, D.E., Brickman, A.M., Sosunov, A.A., Hen, R., McKhann, G.M., Sloan, R., Gage, F.H., Brown, T.R. & Small, S.A. (2007). An in vivo correlate of exercise-induced neurogenesis in the adult dentate gyrus. ***Proceedings of the National Academy of Sciences of the United States of America***. 104(13):5638–5643.

Phillips, D.A. & Hornak, J.E. (1979). ***Measurement and Evaluation in Physical Education***. New York: John Wiley & Sons Inc.

Pierrakeas, C. & Xenos, M. (2004). A comparative study of dropout rates and causes for two different distance education courses. ***International Review of Research in Open and Distance Learning***. 5(2):1–15.

Plowman, S.A. & Smith, D.L. (2014). ***Exercise Physiology for Health, Fitness, and Performance, (4th Edition)***. Baltimore, United States of America: Lippincott Williams and Wilkins.

Pollitt, E., Golub, M., Grantham-McGregor, Levitsky, D., Schurch, B., Strupp, B. & Wachs, T. (1996). A reconceptualization of the effects of undernutrition on children's biological, psychosocial, and behavioral development. ***Society for Research in Child Development***. 10(5):1–21.

Powell, K.E. & Blair, S. (1994). The public health burdens of sedentary living habits: theoretical but realistic estimates. ***Medicine and Science in Sports and Exercise***. 26(7):851–856.

Quadros, T.M., Petroski, E.L., Santos-Silva, D.A. & Pinheiro-Gordia, A. (2011). The prevalence of physical inactivity amongst Brazilian university students: its association with sociodemographic variables. ***Revista de Salud Pública***. 11(5):724–733.

Quatman, T. & Watson, C.M. (2001). Gender differences in adolescent self-esteem: an exploration of domains. ***The Journal of Genetic Psychology***. 162(1):93–117.

Radák, Z., Kaneko, T., Tahara, S., Nakamoto, H., Pucsok, J., Sasvári, M., Nyakas, C. & Goto, S. (2001). Regular exercise improves cognitive function and decreases oxidative damage in rat brain. ***Neurochemistry International***. 38(1):17–23.

Rivkin, S.G., Hanushek, E.A. & Kain, J.F. (2005). Teachers, schools, and academic achievement. ***Econometrica***. 73(2):417–458.

Rodenroth, K.E. “***A study of the relationship between physical fitness and academic performance***” (2010). *Doctoral Dissertations and Projects*. Paper 358. <http://digitalcommons.liberty.edu/doctoral/358>.

Rodenstock, I.M., Stretcher, V.J. & Becker, M.H. (1988). Social learning theory and the Health Belief Model. ***Health Education Quarterly***. 15(2):175–183.

Rojas Vega, S., Strüder, H.K., Vera Wahrmann, B., Schmidt, A., Bloch, W. & Hollmann, W. (2006). Acute BDNF and cortisol response to low intensity exercise and following ramp incremental exercise to exhaustion in humans. ***Brain Research***. 1121(1):59–65.

Ruiz, J.R., Ortega, F.B., Castillo, R., Martin-Matillas, M., Kwak, L., Vicente-Rodriguez, G., Noriega, J., Tercedor, P., Sjöström, M. & Moreno, L.A. (2010). Physical activity, fitness, weight status, and cognitive performance in adolescents. ***The Journal of Pediatrics***. 157(6):917–922.

Russo-Neustadt, A.A., Beard, R.C., Huang, Y.M. & Cotman, C.W. (2000). Physical activity and antidepressant treatment potentiate the expression on specific brain-

derived neurotrophic factor transcripts in the rat hippocampus. **Neuroscience**. 101(2):305–312.

Said, N. (2013). **Predicting academic performance: executive functions, metacognition, study strategies, and self-efficacy**. Orlando: West East Institute.

Saladin, K.S. (2010). **Anatomy and Physiology: The Unity of Form, (5th Edition)**. USA: McGraw-Hill.

Sallis, J.F., McKenzie, T.L., Kolody, B., Lewis, M., Marshall, S. & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: project SPARK. **Research Quarterly for Exercise and Sport**. 70(2):127–134.

Schmelzer, R.V., Schmelzer, C.D. & Figler, R. (1987). Using the critical incident technique to determine reasons for success and failure of university students. **Journal of College Student Personnel**. 28(3):261–266.

Schneider, M. (2002). **Do school facilities affect academic outcomes**. Washington, D.C.: National Clearinghouse for Educational Facilities.

Schwartz, R.A. & Washington, C.M. (2002). Predicting academic performance and retention among African American freshmen men. **Journal of Student Affairs Research and Practice**. 39(4):351–367.

Severson, A. & Barclay, S. (2015). Testosterone levels by age. **Healthline**. 3(1):1–12.

Shariff, I. & Sargent, J.D. (2005). Association between television, movie, and video game exposure and school performance. **Pediatrics**. 118(4):1061–1070.

Shelton, S. (2009). Mind games: let's play with the evolving association between physical activity and academic achievement. **Virginia Journal**. 30(1):4–7.

Shephard, A.J., Pintado, I.P. & Bean, M.H. (2011). Physical education and academic achievement: a review. **Delta Journal of Education**. 1(1):16–23.

Shephard, R.J. (1983). Physical activity and the healthy mind. **Canadian Medical Association Journal**. 128(5):525–530.

Shephard, R.J. (1996). Habitual physical activity and academic performance. **Nutrition Reviews**. 54(4):32–36.

Shephard, R.J. (1997). Curricular physical activity and academic performance. **Pediatric Exercise Science**. 9:113–126.

Shirayama, Y., Chen, A.C., Nakagawas, S., Russell, D.S. & Duman, R.S. (2002). Brain-derived neurotrophic factor produces anti-depressant effects in behavioural models of depression. ***The Journal of Neuroscience: The Official Journal of the Society for Neuroscience***. 22(8):3251–3261.

Sibley, B.A. & Etnier, J.L. (2003). The relationship between physical activity and cognition in children: a meta-analysis. ***Pediatric Exercise Science***. 15(3):243–256.

Sigfusdottir, I.D., Kristjansson, A.L. & Allegrante, J.P. (2007). Health behavior and academic achievement in Icelandic school children. ***Health Education Research***. 22(1):70–80.

Simkins, C., Rule, S. & Bernstein, A. (2007). ***Doubling for growth: addressing the maths and science challenge in South Africa's schools***. Johannesburg: Centre for Development and Enterprise.

Simoës, E.J., Byers, T., Coates, R.J., Serdula, M.K., Mokdad, A.H. & Heath, G.W. (1995). The association between leisure-time physical activity and dietary fat in American adults. ***American Journal of Public Health***. 85(2):240–244.

Siuciak, J.A., Boylan, C., Fritsche, M., Altar, C.A. & Lindsay, R.M. (1996). BDNF increases monoaminergic activity in rat brain following intracerebroventricular or intraparenchymal administration. ***Brain Research***. 710(1–2):11–12.

Smit, M., Wilders, C.J. & Strydom, G.L. (2011). Physical activity and physical fitness profiles of South African women. ***African Journal for Physical, Health Education, Recreation and Dance***. 17(3):450–461.

Sowell, E.R., Thompson, P.M., Tesner, K.D. & Toga, A.W. (2001). Mapping continued brain growth and gray matter density reduction in dorsal frontal cortex: inverse relationships during postadolescent brain maturation. ***The Journal of Neuroscience: The Official Journal of the Society for Neuroscience***. 21(22):8819–8829.

Sparling, P.B. & Snow, T.K. (2002). Physical activity patterns in recent college alumni. ***Research Quarterly for Exercise and Sport***. 73(2):200–205.

Spence, J.C. & Lee, R.E. (2003). Toward a comprehensive model of physical activity. ***Psychology of Sport and Exercise***. 4(1):7–24.

Sperry, R.E., Vacek, J.L. & Smith, G.S. (1991). The effects of smoking on the signal-averaged electrocardiogram in normal subjects. ***Chest***. 99(1):121–122.

Squire, L.R., Stark, E.E. & Clark, R.E. (2004). The medial temporal lobe. ***Annual Review of Neuroscience***. 27:279–306.

Steptoe, A., Edwards, S., Moses, J. & Matthews, A. (1989). The effects of exercise training on the mood and perceived coping ability in anxious adults from the general population. ***Journal of Psychosomatic Research***. 33(5):537–547.

Stevens, J., Cai, J., Evenson, K.R. & Thomas, R. (2002). Fitness and fatness as predictors of mortality from all causes and from cardiovascular disease in men and women in the lipid research clinics study. ***American Journal of Epidemiology***. 156(9):832–841.

Stewart-Brown, S., Evans, J., Patterson, J., Doll, H., Balding, J. & Regis, D. (2000). The health of students in institutes of higher education: an important and neglected public health problem? ***Journal of Public Health Medicine***. 22(4):492–499.

Stone, E.J., McKenzie, T.L., Welk, G.J. & Booth, M.L. (1998). Effects of physical activity interventions in youth. ***American Journal of Preventive Medicine***. 15(4):298–315.

Stovitz, S.D. & Batt, M.E. (2010). The epidemic has gone global: can exercise and medicine quell the tide? ***British Journal of Sports Medicine***. 44(10):693.

Strong, W. B., Malina, R. M., Binkie, C. J. R., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Must, A., Nixon, P. A., Pivarnik, J. M., Rowland, T., Trost, S. & Trudeau, F. (2005). Evidence based physical activity for school-age youth. ***The Journal of Pediatrics***. 146(6):732–737.

Strydom, J.F. & Mentz, M. (2010). ***Focusing the student experience on success through student engagement***. Pretoria: Council on Higher Education.

Strydom, J.F., Mentz, M. & Kuh, G.D. (2010). ***Enhancing success in higher education by measuring student engagement in South Africa***. Pretoria: Council on Higher Education.

Studenski, S., Carlson, M.C., Fillit, H., Greenough, W.T., Kramer, A. & Rebok, G.W. (2006). From bedside to bench: does mental and physical activity promote cognitive vitality in late life? ***Science of Aging Knowledge Environment***. 2006(10):21.

Sutton, A. & Soderstrom, I. (1999). Predicting elementary and secondary school achievement with school-related and demographic factors. ***The Journal of Educational Research***. 92(6):330–338.

Tachmes, L., Fernandez, R. & Sackner, M.A. (1978). Hemodynamic effects of smoking cigarettes of high and low nicotine content. **Chest**. 74(3):243–246.

Talbot, G.L. (1990). Personality correlates and personal investment of college students who persist and achieve. **Journal of Research and Development in Education**. 24(1):53–57.

Taras, H. (2005). Physical activity and student performance at school. **The Journal of School Health**. 75(6):214–218.

Taylor, C.B., Sallis, J.F. & Needle, R. (1985). The relation of physical activity and exercise to mental health. **Public Health Reports**. 100(2):195–202.

Thawabieh, A.M. & Qaisy, L.M. (2012). Assessing stress among university students. **American International Journal of Contemporary Research**. 2(2):110–116.

Thirlaway, K. & Benton, D. (1992). Participation in physical activity and cardiovascular fitness have different effects on mental health and mood. **Journal of Psychosomatic Research**. 36(7):657–665.

Thomas, J.R. & Nelson, J.K. (2001). **Research Methods in Physical Activity, (4th Edition)**. Illinois: Human Kinetics.

Thomas, J.R., Nelson, J.K. & Silverman, S. (2011). **Research Methods in Physical Activity, (6th Edition)**. Illinois: Human Kinetics.

Tinto, V. (2006). Research and practice of student retention: what next? **Journal of College Student Retention**. 8(1):1–19.

Tomporowski, P.D. (2003). Effects of acute bouts of exercise on cognition. **Acta Psychologica**. 112(3):297–324.

Tomporowski, P.D., Davis, C.L., Miller, P.H. & Naglier, J.A. (2008). Exercise and children's intelligence, cognition, and academic achievement. **Educational Psychology Review**. 20(2):111–131.

Toutkoushian, R.K. & Curtis, T. (2005). Effects of socioeconomic factors on public high school outcomes and rankings. **The Journal of Educational Research**. 98(5):259–271.

Townsend, N., Bhatnagar, P., Wickramasinghe, K., Scarborough, P., Foster, C. & Rayner, M. (2012). **Physical Activity Statistics 2012**. London: British Heart Foundation.

Tremblay, S., Inman, J.W. & Willms, J.D. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. ***Pediatric Exercise Science***. 12(3):312–323.

Trost, G. (2007). ***Active Education: physical education, physical activity and academic performance***. San Diego: Active Living Research, Robert Wood Foundation.

Trost, S.G. & Van der Mars, H. (2010). Why we should not cut P.E. ***Health and Learning***. 67(4):60–65.

Trudeau, F. & Shephard, R.J. (2008). Physical education, school physical activity, school sports and academic performance. ***International Journal of Behavioral Nutrition and Physical Activity***. 5(1):1–10.

Trudeau, F. & Shephard, R.J. (2010). Relationships of physical activity to brain health and the academic performance of schoolchildren. ***American Journal of Lifestyle Medicine***. 4(2):138–150.

Tshwane University of Technology. ***Admission point score system***. (<http://www.tut.ac.za/enrol/Admissions/Pages/APS.aspx>). Retrieved 25 July 2015.

Tsouros, A.G., Dowding, G., Thompson, J. & Dooris, M. (1998). ***Health promoting universities: concept, experience and framework for action***. Copenhagen: World Health Organization.

Tuckman, B.W. & Hinkle, J.S. (1986). An experimental study of the physical and psychological effects of aerobic exercise on school children. ***Health Psychology***. 5(3):197–207.

Tully, M.A. & Cupples, M.E. (2011). UNISTEP (University students exercise and physical activity) study: a pilot study of the effects of accumulating 10,000 steps on health and fitness among university students. ***Journal of Physical Activity and Health***. 8(5):663–667.

US Department of Health and Human Services. (1996). ***Physical activity and health: a report of the surgeon general***. Atlanta: Centres for Disease Control and Prevention.

US Department of Health and Human Services. (2000). ***Healthy people 2010: understanding and improving health***. Washington, D.C.: US Department of Health and Human Services.

- Vail, K. (2006). Is physical fitness raising grades? ***American School Board Journal***. 71(8):13–19.
- Van der Merwe, M.T. & Pepper, M.S. (2006). Obesity in South Africa. ***The International Association for the Study of Obesity: Obesity Reviews***. 7(4):315–322.
- Van Dusen, D.P., Kelder, S.H., Kohl, H.W., Ranjit, N. & Perry, C.L. (2011). Associations of physical fitness and academic performance among schoolchildren. ***Journal of School Health***. 81(12):733–740.
- Van Praag, H. (2008). Neurogenesis and exercise: past and future directions. ***Neuromolecular Medicine***. 10(2):128–140.
- Van Praag, H., Kempermann, G. & Gage, F.H. (1999). Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. ***Nature Neuroscience***. 2(3):266–270.
- Van Schalkwyk, S. (2002). Dealing with the dilemma facing higher education in South Africa against the backdrop of economic globalization – a technikon perspective. ***South African Journal of Higher Education***. 16(1):183–187.
- Varela-Mato, V., Cancela, J.M., Ayan, C., Martin, V. & Molina, A. (2012). Lifestyle and health among Spanish students: differences by gender and academic discipline. ***International Journal of Environmental Research and Public Health***. 9(8):2728–2741.
- Vaynman, S. & Gomez-Pinilla. (2006). Revenge of the “sit”: how lifestyle impacts neuronal and cognitive health through molecular systems that interface energy metabolism with neuronal plasticity. ***Journal of Neuroscience Research***. 84(4):699–715.
- Wang, T., Xie, K. & Lu, B. (1995). Neurotrophins promote maturation of developing neuromuscular synapses. ***The Journal of Neuroscience: The Official Journal of the Society for Neuroscience***. 15(7):4796–4805.
- Wang, X. “***Performance measurement in universities: managerial perspective***” (2010). *University of Twente Student Theses*. <http://purl.utwente.nl/essays/60180>.
- Warburton, D.E., Nicol, C.W. & Bredin, S.S. (2006). Health benefits of physical activity: the evidence. ***Canadian Medical Association Journal***. 174(6):801–809.
- Weissman, M.M. & Klerman, G.L. (1992). Depression: current understanding and changing trends. ***Annual Review of Public Health***. 13(1):319–339.

Welk, G.J., Jackson, A.W., Morrow, J.R., Haskell, W.H., Meredith, M.D. & Cooper, K.H. (2010). The association of health-related fitness with indicators of academic performance in Texas schools. **Research Quarterly for Exercise and Sport**. 81(3):16–23.

Wengreen, H.J. & Moncur, C. (2009). Change in diet, physical activity, and body weight among young-adults during the transition from high school to college. **Nutrition Journal**. 8(1):32–37.

Wiecha, L.J., Sobol, A.M., Peterson, K.E. & Gortmaker, S.L. (2007). Household television access: associations with screen time, reading, and homework among youth. **Ambulatory Pediatrics: The Official Journal of the Ambulatory Pediatric Association**. 1(5):244–251.

Winter, B., Breitensten, C., Mooren, F.C., Voelker, K., Fobker, M., Lechtermann, A., Krueger, K., Fromme, A., Korsukewitz, C., Floel, A. & Knecht, S. (2007). High running improves learning. **Neurobiology of Learning and Memory**. 87(4):597–609.

Wintre, M.G. & Yaffe, M. (2000). First-year students' adjustment to university life as a function of relationships with parents. **Journal of Adolescent Research**. 15(1):9–37.

Woodward, J.B. “**A study of physical fitness and academic performance levels of sixth and seventh grade students**” (2009). *Doctoral Dissertations and Projects*. Paper 309. <http://digitalcommons.liberty.edu/doctoral/309>.

World Health Organization. (2010). **Global status report on noncommunicable diseases**. Geneva: World Health Organization.

Yaffe, K., Barnes, D., Nevitt, M., Lui, L. & Covinsky, K. (2001). A prospective study of physical activity and cognitive decline in elderly women. **Archives of Internal Medicine**. 161(14):1703-1708.

Yarrow, J.F., White, L.J., McCoy, S.C. & Borst, S.E. (2010). Training augments resistance exercise induced elevation of circulating brain derived neurotrophic factor (BDNF). **Neuroscience Letters**. 479(2):161–165.

Yu, C.C.W., Chan, S., Cheng, F. & Sung, R.Y. (2006). Are physical activity and academic performance compatible? Academic achievement, conduct, physical activity and self-esteem of Hong Kong Chinese primary school children. **Educational Studies**. 32(4):331–341.

Zoeller, R.F. (2010). Exercise and cognitive function: can working out train the brain, too? ***American Journal of Lifestyle Medicine***. 4(5):397–409.



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APPENDICES

APPENDIX A: Informed consent form

“Does a relationship exist between physical fitness and academic performance in university students?”

Dear participant

PURPOSE:

I am currently enrolled as a student at The University of Pretoria for the MA(HMS) degree. I am conducting a research study on *“Does a relationship exist between physical fitness and academic performance in university students”*. This research will assist the University to provide an environment for students to maximise their chances of academic achievement.

PROCEDURES:

Voluntary participants will be tested in order to gather research data. The testing will take approximately an hour at a time during the first week of January, May and October 2014. The participants must wear comfortable clothes for testing. Testing will take place in a controlled environment. The five health-related components of fitness will be measured using the following tests:

1. **Cardiovascular endurance** – Cardiovascular endurance is a physiological aspect with the ability to carry out dynamic exercise at moderate to high intensity, for prolonged periods at a time. Cardiovascular endurance will be measured using the Harvard step test. The Harvard step test requires the individual to step up and down a bench to the sound of a metronome. The metronome is set at a rhythm of 30 steps per minute. Male students will make use of a 50 cm box whereas female students will make use of a 40 cm box. After 5 minutes for males and 4 minutes for females the participant sits down immediately. Heart rate is recorded at the 1st, 2nd, and the 3rd minute after the work has stopped.
2. **Flexibility** – Flexibility is the ability to move a joint through its complete range of motion. Flexibility will be measured using the sit and reach test. The participant sits with his/her back against the wall and his/her legs fully extended in front of him/her. Arms are extended forward with the one hand on top of the other. The participant leans as far forward as possible, keeping his/her legs flat on the floor and holding that position for 2 seconds.
3. **Muscular strength** – Muscular strength refers to the external force that can be generated by a specific muscle or a muscle group. Muscular strength will be measured using the handgrip dynamometer. The participant stands upright with the elbow bent at a 90 degree angle. The shoulder must be adducted and neutrally rotated. The forearm is in a neutral position and the wrist extended from 0–30 degrees. The participant is required squeeze the dynamometer as hard as possible. There will be three trials for each hand.
4. **Muscular endurance** – Muscular endurance is the ability of a muscle group to execute repeated contractions over a period of time sufficient to cause muscular

fatigue. Muscular endurance will be assessed using the minute sit-up test. The participant lies on his/her back with his/her knees bent. The fingers must be interlocked behind the neck with the hands touching the mat. Another person will hold the participants ankles. The participant must perform as many sit-ups as possible in a minute.

5. Body composition – Body composition is used to describe the percentage of fat, bone and muscle in human bodies. Body composition will be measured using the Heath and Carter Somato-type method. A tape measure, skinfold calliper, spreading calliper, a weighing scale, and a stadiometer is needed for the measurements. The following measurements will be taken:

- **Height** – The participant stands with his/her heels, buttocks, and upper back touching the stadiometer. The heels must be together, and the head should be in the Frankfurt plane (orbitale and the tracion should be in the same horizontal plane). When the participant is instructed to inhale, the recorder will lower the head board firmly on the vertex. The measurement is taken before the participant exhales.
- **Weight** – The participant stands on the centre of the scale with his/her feet distributed evenly.
- **Tricep skinfold measurement** – The participant stands upright in the neutral position, with the right arm relaxed. The measurement is taken between the acromion and the radiale parallel to the long axis of the arm.
- **Subscapular skinfold measurement** – The skinfold measurement is taken with the fold running laterally and obliquely downwards at a 45 degree angle.
- **Bicep skinfold measurement** – The skinfold measurement is taken on the anterior surface of the arm at the level of the mid-acromiale-radiale landmark, parallel to the long axis of the arm.
- **Supra-iliac skinfold measurement** – The measurement should be taken with the participants arm placed across his/her chest and is measured horizontally at the Iliac crest skinfold site.
- **Medial calf skinfold measurement** – The participants right foot is placed on a box, with the knee bent at a 90 degree angle. The skinfold measurement is taken at the most medial part of the calf with the fold being parallel to the long axis of the leg. The measurement will be taken at the level of the maximal girth.
- **Calf circumference measurement** – The participant stands with his/her feet shoulder width apart, weight evenly distributed. The tape measure is placed around the maximal girth of the calf and recorded.
- **Contracted arm circumference** – The arm is flexed at a 90 degree angle and is raised anteriorly to the horizontal. The tape measure is placed around the largest part of the biceps brachii. The circumference measurement is taken when the participant contracts his/her arm.
- **Waist circumference** – The participant stands with his/her arms folded across the thorax, breathing normally. The measurement is recorded at the end of expiration at the smallest circumference of the abdomen.
- **Hip circumference** – The participant assumes a relaxed standing position, with the feet together, the gluteal muscles relaxed and the arms folded across

the thorax. The measurement is recorded at the level of the greatest posterior circumference of the buttocks.

- **Humerus diameter measurement** – The participant bends his/her elbow at a 90 degree angle. The measurement is taken at the most medial aspect of the medial humeral epicondyle and the most lateral humeral epicondyle.
 - **Femur diameter measurement** – The measurement is taken on the most medial aspect of the medial femoral epicondyle and the most lateral aspect of the lateral femoral condyle. This measurement is taken with the participants right leg flexed at a 90 degree angle. The foot can be resting on the floor.
6. **Semester marks** – Academic performance will be measured by taking the participant's cumulative weighted average.
 7. **AP score** – The researcher will make use of the participants matric Admission Point Score.
 8. **Health status screening** – The participant will complete Belloc and Breslow's Lifestyle questionnaire as it is considered a valid and an acceptable measure of health status.
 9. **Socioeconomic status** – The participant's mothers highest education achieved will be used to represent the participants socioeconomic status.

RISKS AND DISCOMFORTS:

The risks involved in this study could include, but are not limited to, muscle pain, muscle stiffness, fatigue, dizziness, and in rare instances heart attack, stroke or death.

BENEFITS:

Through the tests the participant will be able to determine how each of their components of fitness (including cardiovascular endurance, muscle endurance, muscle strength, flexibility, and body composition rate).

CONFIDENTIALITY:

All information will be kept confidential thus ensuring that only the researcher, the supervisor, the statistician and the university authorities will know how he/she has performed. All test results will be destroyed should the participant decide that no further participation is required. Only the University of Pretoria, the participant, and the researcher will have access to the research data. The data will be stored for 15 years at the Institute for Sport Research and may be used for further research, writing articles or presentations at conferences.

Take note that the participant's participation is voluntary and that you are not being forced to take part in this study. The choice of whether you participate or not, is solely in your hands. However, it will be appreciated if you share your thoughts with the researcher. Although you agree to participation, you retain the right to withdraw from participation in the study at any time, without negative consequences.

.

I, _____ (full name of participant),
have read the above and have been informed of the procedures, requirements,
benefits and risks of participating in this research project.

I hereby also grant permission to participate in this research study, and that I will not
withhold any information that may be of importance to the researcher. I hereby also
grant the researcher permission to use my data of my participation in this study and
that my results may be used for publication and/or presentation purposes, with
anonymity ensured.

Signature of participant

Signature of witness

Signature of researcher

Date

Contact telephone number: _____

Email address: _____

Researcher's contact details

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APPENDIX B: Indemnity form

I, the undersigned, hereby declare and agree as follows towards the Institute for Sport Research (hereinafter referred to as the ISR) at the University of Pretoria (hereinafter referred to as the “UNIVERSITY”):

1. I wish to participate in this research project. I realize that my participation in such a project involves risks of injury, including, but not limited to musculoskeletal injury, abnormal blood pressure, fainting, irregular, fast, or slow heart rhythm, and in rare instances, heart attack, stroke, or death. I realize that there are many other risks of injury, including serious disabling injuries that may arise due to my participation in such a project, and that it is not possible to specifically list each and every individual injury risk. However, knowing the material risks and appreciating, knowing, and reasonably anticipating the other injuries and even risk of death, which could occur by reason of my participation in the project, I abide by and submit myself herewith to the applicable conditions and regulations of the ISR at the UNIVERSITY, which shall include but not be limited to the conditions and regulations pertaining to the ISR and/or the UNIVERSITY’s facilities and services such as evaluation, and general use of the ISR and/or the UNIVERSITY’s facilities and equipment
2. I herewith indemnify and hold harmless the UNIVERSITY against all claims instituted by myself or my family, resulting from any loss, damage, injury or death, which I may sustain as a result of the use of the ISR and/or the UNIVERSITY’s facilities and/or participation in the project.
3. I understand that my participation in this research project at the ISR shall be at my own risk and that this indemnity includes all employees and subcontractors of ISR and the UNIVERSITY.
4. I have an opportunity to ask questions. Any questions I have asked have been answered to my complete satisfaction. I subjectively understand the risks I voluntarily choose to participate, assuming all risks of injury or even death due to my participation.
5. The information that is obtained will be treated as confidential, and the ISR has undertaken not to release or reveal such information to any person, except for the researcher and research department, without my consent. The information

obtained may be used for statistical analysis or scientific purposes with my right of privacy being retained.

6. I hereby declare that all information regarding my health and which may cause a health risk have been disclosed to the UNIVERSITY and accept the clause regarding the use and archiving of my medical records.

7. I have read the abovementioned information before signing below and fully understand the contents, meaning and impact thereof.

Name of prospective participant

Signature of prospective participant

Signed at _____ on this _____ day of _____ 2014

Contact number: _____ Email: _____

Witness: _____

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APPENDIX C: Par-Q form

YES	NO	QUESTION
		Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
		Do you feel pain in your chest when you do physical activity?
		In the past month, have you had chest pain when you were not doing physical activity?
		Do you lose your balance because of dizziness or do you ever lose consciousness?
		Do you have a bone or joint problem (for example, back, knee, or hip) that could be made worse by a change in your physical activity?
		Is your doctor currently prescribing drugs (for example, water pills) for blood pressure or a heart condition?
		Do you know of any other reason why you should not do physical activity?

If you answered yes to one or more questions:

Talk with your doctor BEFORE you start becoming much more physically active, or before you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES

If you answered no to one or more questions:

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can take part in a fitness appraisal

"I have read, understood and completed this questionnaire. Any questions I had, were answered to my full satisfaction"

NAME: _____

SIGNATURE: _____

DATE: _____

WITNESS: _____



APPENDIX D: Belloc and Breslow Lifestyle Questionnaire

Please mark the following statements in the applicable space with an “X” that indicates your current lifestyle habits

YES	NO	QUESTION
		Do you eat three meals a day at regular times with no snacks in between?
		Do you eat breakfast every day?
		Do you participate in moderate exercise two or three times a week?
		Do you get 7 to 8 hours sleep at night?
		Are you a non-smoker?
		Do you maintain a moderate body weight?
		Do you consume little or no alcohol?



APPENDIX E: Participant's feedback report

GENERAL PHYSIOLOGICAL ASSESSMENT

Test Date: _____

Researcher: Danielle Steenkamp

Name: _____

HEALTH SCREENING QUESTIONNAIRE

<u>DATE</u>	<u>TEST 1: JANUARY 2014</u>	<u>TEST 2: MAY 2014</u>	<u>TEST 3: OCTOBER 2014</u>
<u>LIFESTYLE CATEGORY</u>	<u>(Unhealthy / Moderate / Healthy Lifestyle)</u>	<u>(Unhealthy / Moderate / Healthy Lifestyle)</u>	<u>(Unhealthy / Moderate / Healthy Lifestyle)</u>
	_____	_____	_____

ANTHROPOMETRY AND BODY COMPOSITION

Anthropometry is the process of measuring physical dimensions of the human body. These measurements provide indirect estimation of a person's body composition. Sheldon's morphological classification includes the ectomorph, the mesomorph, and the endomorph. An ectomorph is a slender person with a light frame, the legs and arms are slender long, and the muscle tissue has little definition. A mesomorph is an athletic-looking individual with broad shoulders, narrow hips with predominant muscle tissue. An endomorph is a thick individual; the arms and legs are short, compared with the torso, while the chest and waist are about the same size. Of importance is that excess body fat serves no useful function and represents only extra weight to be carried around. Excess fat is associated with hypertension, Type 2 diabetes, stroke artery disease, and hyperlipidemia. Body composition is thus an important aspect of fitness or physical activity

	Jan-14	May-14	Oct-14
STATURE (cm)			
WEIGHT (kg)			
BODY MASS INDEX			
FAT PERCENTAGE	%	%	%

BMI is the relationship between height and weight providing us with an indication of your body composition. BMI can be improved through regular exercise and a controlled healthy eating planning. This will result in a decrease in your weight.

Body fat percentage refers to the percentage of your body weight that is fat tissue. Your genetic make-up and lifestyle largely determine your body fat and body composition. Excess body fat is associated with many chronic diseases. A very low body fat, however, is not necessarily healthy.

NORMS - BODY MASS INDEX (BMI)	
Underweight	<18.5
Normal	18.5-24.9
Overweight	25.0-29.9
Obesity - I	30.0-34.9
II	35.0-39.9
III	>40

NORMS – BODY FAT PERCENTAGE

PERCENTILE	RATING	MALES	FEMALES
90	EXCELLENT	7.1	14.5
80		9.4	17.1
70	GOOD	11.8	19
60		14.1	20.6
50	AVERAGE	15.9	22.1
40		17.4	23.7
30	POOR	19.5	25.4
20		22.4	27.7
10	EXTREMELY BAD	25.9	32.1

FLEXIBILITY: Sit-and-Reach Test

An important component of muscular performance is flexibility. Flexibility refers to the range of movement of a joint or the range of movement of a group of joints. Flexibility is specific to each joint which implies that being flexible in one joint does not indicate that there will be high flexibility in another joint

DATE	Measurement
Jan-14	
May-14	
Oct-14	

NORMS – FLEXIBILITY

PERCENTILE	MALES	FEMALES
99	62.7	53.3
95	48	49
90	43.7	45.5
80	43.2	42.4
70	40.1	41.1
60	38.1	40.1
50	36.6	37.6
40	34.3	36.8
30	33	34.8
20	29.5	32
10	23.4	25.7

MUSCLE STRENGTH: Handgrip DynanometerTest

Muscular strength refers to the force or tension that a muscle, or muscle group is able to exert in one maximal contraction against a resistance

	Sum of Left & Right hand
Jan-14	
May-14	
Oct-14	

NORMS – MUSCLE STRENGTH

	MALE	FEMALE
EXCELLENT	>/=115	>/=70
VERY GOOD	104-114	63-69
GOOD	95-103	58-62
FAIR	84-94	52-59
NEEDS IMPROVEMENT	</=83	</=51

MUSCLE ENDURANCE: One minute sit-ups

Muscular endurance is defined as the muscle or muscle groups ability to perform repeated contractions for a lengthened period of time against a light load.

	Number of sit-ups
Jan-14	
May-14	
Oct-14	

NORMS – MUSCLE ENDURANCE

PERCENTILE RANK	MALE	FEMALE
99	>55	>51
90	52	49
80	47	44
70	45	41
60	42	38
50	40	35
40	38	32
30	35	30
20	33	27
10	30	23
1	<27	<18

CARDIOVASCULAR ENDUARNCE: Harvard Step Test

One of the most important components of physical fitness is cardiovascular endurance (Heyward, 2006), also referred to as cardio-respiratory endurance (Plowman & Smith, 2014), aerobic power or endurance fitness (U.S. Department of Health and Human Services, 1996). Cardiovascular endurance is a physiological aspect (Lindwall *et al.*, 2012) with the ability to carry out dynamic exercise at a moderate intensity for prolonged periods at a time.

	HEART RATE SCORE
Jan-14	
May-14	
Oct-14	

NORMS – CARDIOVASCULAR ENDURANCE

PERCENTILE RANK	
EXCELLENT	>89
GOOD	80-89
AVERAGE	65-79
LOW AVERAGE	55-64
POOR	<55

“Thank you for taking the time to participate in this research study. I hope you learnt something valuable along the way. Good luck with your future endeavors”.