

**THE INFLUENCE OF EXERGAMING ON THE PHYSICAL FITNESS; ATTITUDE
TOWARDS PHYSICAL ACTIVITY; AND SELF-CONCEPT IN OVERWEIGHT AND
OBESE CHILDREN**

BY

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature:

Date:

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DEDICATION

I dedicate this thesis to my farther,

Wim van Biljon

14/10/1963 – 16/05/2010

The Lord is my shepherd, I shall not want; He makes me lie down in green pastures. He leads me beside still waters; He restores my soul. He leads me in paths of righteousness for His name's sake. Psalm 23:1-3

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LIST OF ABBREVIATIONS

| ABBREVIATION | TERM |
|-----------------|--|
| ACSM | American College of Sports Medicine |
| BM | Body mass |
| BMI | Body mass index |
| BMR | Basal metabolism rate |
| BP | Blood pressure |
| DBP | Diastolic blood pressure |
| DDR | Dance dance revolution |
| HR | Heart rate |
| ISAK | International Society for the Advancement of Kinanthropometry |
| LS | Left side |
| M | Mean |
| n | Sample size |
| nd | No date |
| PACER | Progressive aerobic cardiovascular endurance run |
| PE | Physical education |
| RHR | Resting heart rate |
| RS | Right side |
| SBP | Systolic blood pressure |
| SD | Standard deviation |
| SES | Socioeconomic status |
| TEE | Total energy expenditure |
| VO ₂ | Volume of oxygen |
| WHO | World Health Organization |
| WHR | Waist to hip ratio |

ABSTRACT

THE INFLUENCE OF EXERGAMING ON THE PHYSICAL FITNESS; ATTITUDE TOWARDS PHYSICAL ACTIVITY; AND SELF-CONCEPT IN OVERWEIGHT AND OBESE CHILDREN

The rapidly growing rate of childhood obesity makes it imperative to develop an effective intervention program for obese children. This study was an attempt to answer the question as to whether exergaming can drive overweight and obese children towards adopting a healthier lifestyle, becoming more physically active for life and improving their self-concept. The study consisted of a 6-week intervention on the Nintendo Wii. Participants were aged between 9-12 years old. Subjects were assigned to three groups according to location: experimental group (n=11), control group A (n=10) and control group B (n=10). The experimental group participated in the exergaming intervention program, control group A had access to traditional video games and control group B continued with their everyday life activities with no intervention. Health-related- and functional-fitness protocols were used to assess the physical fitness of the subjects. The Cratty Self-concept questionnaire determined self-concept amongst subjects and a closed-ended interview was conducted to conclude changes in attitude towards physical activity. Statistical calculations revealed that the experimental group showed significant improvement in their level of functional fitness ($p < 0.05$). Coordination, reaction time, speed and agility increased by magnitudes of 28%, 94% and 37% respectively. Reductions in resting- blood pressure and heart rate mean scores were observed. Both the control groups displayed marginal increases in their overall level of fitness that were not significant. No changes were observed and recorded for self-concept and attitude towards physical activity across the board. These results support the concept that exergaming can be used as an alternative means to improve the level of functional fitness as well as promoting physical activity in children.

Key words: Physical Fitness; Physical Activity; Self-concept; Child Obesity; Exergaming; Nintendo Wii

OPSOMMING

DIE INVLOED VAN “EXERGAMING” OP DIE FISIEKE; HOUDING TEENoor FISIEKE AKTIWITEITE EN SELF KONSEP IN OORGEWIG EN OBEES KINDERS

Hierdie studie was ‘n poging om die vraag te antwoord of exergaming wel oorgewig en obese kinders kan oorrede om ‘n gesonder leefstyl aanteneem, meer fisiek aktief te word en hulle selfkonsep te verbeter. n’ Beskikbaarheidsteekproef van 30 oorgewig en obese proefpersone tussen die ouderdomme van neges 9-12 jaar oud was betrokke. Die proefpersone was ingedeel in drie navorsing groepe, naamlik die eksperimentele groep (n=11), kontrolegroep A (n=10) en kontrolegroep B (n=10). Die eksperimentele groep het toegang gekry tot die Nintendo Wii speeletjies vir 6-week, kontrolegroep A het toegang gehad tot tradisionele video speeletjies en kontrolegroep B het voortgegaan met hulle alle daagse aktiwiteite met geen intervensie nie. Gesonde verwante fiksheid as ook funksionele verwante fiksheid protokole was gebruik om die fisieke fiksheid te toets. Die Cratty Selfkonsep vraelys het die self konsep bepaal tussen die navorsing groepe en ‘n toegeslote onderhoud was gevoer om ening veranderinge te bepaal in die houding teenoor fisieke aktiwiteit gedurende die studie. Statistieke berekeninge vertoon dat die eksperimentele groep ‘n betekenisvolle vordering gemaak het in hulle funksionele fiksheid vlakke ($p < 0.05$). Koördinasie, reaksie tyd, spoed en handigheid het toegeneem met ‘n grootte van 28%, 94%, en 37% onderskeidelik. Afnames in bloeddruk en hart tempo gemiddelde telling word gesien. Al twee kontrolegroepe A en B wys min verbeterings in hulle algemene fiksheid vlak. Geen veranderinge was vasgesel vir selfkonsep en houding teenoor fisieke aktiwiteit regoor die navorsing groepe. Hierdie resultate ondersteun die konsep dat exergaming wel gebruik kan word as ‘n alternatiewe middel om funksionele fiksheid vlakke te verbeter.

Sleutelwoorde: Fisieke Fiksheid; Fisieke-aktiwiteit; Selfkonsep; Kinder Obesiteit; Exergaming; Nintendo Wii

CHAPTER ONE

INTRODUCTION

The World Health Organization (2003) claims that the conditions of being overweight and obese are global epidemics with more than 1 billion people already classified as being overweight or obese. Twenty-two million of the 1 billion are overweight and obese children under 5 years old. The term obesity is derived from the Latin word “*obesus*” meaning fat or plump. Body fat is located just under the skin and is vital to maintain health in the sense of regulating body temperature, absorbing shock and storing nutrients. Every person should have a certain amount of body fat in order to be healthy. Overfatness is a synonym for obesity and may further clarify the vagueness around what obesity really means (Corbin & Lindsey, 1997). Obesity places great emphasis on excess body fat, rather than body fat alone. Thus, by analyzing the definition of obesity it becomes clear that it is not body fat which is the source of this worldwide epidemic but the struggle to maintain desirable fatness levels.

Accumulated body fat would have been advantageous to survival during periods of scarcity in providing reserves when food was short. Ironically, in such times physical activity is usually part of daily life, thus making obesity impossible (Daniels et al., 2005). Today, however many people celebrate unlimited quantities and accessibility of food which has proved to be problematic as sedentary lifestyles have become established. Research reports that today’s children expend significantly less energy than their counterparts of 50 years ago (Durnin, 1992). Obesity is very common and somewhat of a reality in modern times. Limited opportunities for physical activity, the growing popularity and availability of junk food and lack of access to preventative healthcare services are factors of modern life which impact the attempts to lose or maintain healthy weight levels (Shah, 2010). In 2000, excess accumulation of body fat was diagnosed as a medical condition associated with reduced life expectancy, termed obesity (Obesity, n.d.).

There are many ways of evaluating body fatness, body mass index (BMI) is a simplified and the most often used measurement calculated by dividing weight by the square of height. While body mass index is based on height and weight it does not take into account child development factors such as growth patterns and distribution of fat (Hardy, Harrell & Bell,

2004). Gender- and age-specific growth charts assess a child's weight status as a percentile that indicates the relative position of the child's body mass index number among children of the same age and sex. The growth charts categorize a child as being overweight between the 85th and 95th percentile. Child obesity is defined with a body mass index higher than the 95th percentile (Cole, Bellizzi, Flegal & Dietz, 2000). The prevalence of child obesity in the US has doubled within 3 decades and similar increases have been observed in other countries including developing countries (Ogden & Carroll, 2010).

Obesity is linked to several serious health problems and medical conditions (Baechle & Earle, 1994). Daniels et al. (2005) outline the main adverse consequences as metabolic, orthopedic, cardiovascular, psychological, hepatic, pulmonary and renal pathologies. These comorbidities reflect decreases in physical activity and dietary changes. It is inevitable that a combination of high caloric intake with reduced physical activity is a recipe for obesity (Dasgupta, Kim, Kogan & Novitzky, 2007). Research supports the association between physical inactivity and increased rates of overweight and obesity (Andersen, Crespo, Bartlett, Cheskin & Pratt, 1998; Laurson et al., 2008).

Physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure. Experts recommend a minimum of 60 min of physical activity on most days of the week (Strong et al., 2005). Physical activity improves cardiovascular fitness, muscular strength, body agility, coordination, bone density, lipid profiles, insulin levels and immune function. It reduces the risk of cardiovascular disease, type 2 diabetes, colon cancer and osteoporosis. Regular physical activity provides the individual with physical benefits and is at the same time associated with enhanced self-esteem and increased academic performance (Scheuer & Mitchell, 2003).

Being able to perform daily tasks without fatigue is measured as physical fitness. Physical fitness includes components of cardiovascular endurance, muscular and strength endurance, body composition, flexibility, speed and agility, coordination, power, reaction time and balance. Obesity affects one's physical fitness because excess weight interferes with performance of tasks that require lifting the body mass (Kamtsios & Digelidis, 2007). Moreover, weight-bearing activities require more effort from obese children than their non-obese peers, given that energy expenditure increases with body mass index (McArdle, Katch & Katch, 2007).

Consequently obese individuals tend to shun weight bearing activities which may contribute to reduced physical fitness as they lack experience in activities such as jumping, running, fundamental locomotor skills and dynamic balance. Although a negative relationship exists between fatness and performance in both endurance and weight bearing tasks, flexibility appears to be similar in obese and normal weight children (D'Hondt, Deforche, De Bourdeaudhuij, Lenoir, 2009). According to the US Health and Human Services (2007), social discrimination is a perceived consequence for overweight children. Studies have shown that participating in physical activity increases self-esteem and self-perception (Goldfield, Kalakanis, Ernst & Epstein, 2000; Hughes, McLaughlin, McKay & Mutrie, 2007).

Self-concept is an umbrella term for the values, attitudes and meanings a person has about himself or herself. It is the broad knowledge that individuals have regarding to themselves (Sherrill, 2004). Self-concept may be illustrated by the individual's perception of himself or herself (Malina, Bouchard & Bar-Or, 2004). Children between the ages of 9-11 years have a high awareness of the differences between them. This extends to discrimination against overweight and obese children, leaving them to feel outcast and rejected. Various studies show that obese children between the ages of 6-18 years have lower self-perception than their peers of normal weight (Kimm et al., 1997; Davison & Birch, 2001; Young-Hyman et al., 2006). Research has found that obese children have low perceptions of their athletic competency, physical appearance and self-worth. Compromised self-perception may have multiple consequences, thus making obesity a multifactor disease that is highly resistant to treatment (Franklin, Denyer, Steinbeck, Caterson & Hill, 2006).

Daniels et al. (2005) summarized guiding principles that are important for the treatment of overweight as follows: individual treatment goals should be established; family members should be involved; assessment should be done on a frequent basis; the behavioral, psychological and social factors of weight gain should be incorporated; physical activity should be increased; and recommendations on dietary changes that can be implemented within the family environment should be provided. Regular physical activity seems to be emphasized in most reports of successful weight loss programs (Barlow & Dietz, 1998). Instead of treating obese individuals, Du Toit and Pienaar (2003) propose the use of modern technology such as active video games, as an enjoyable alternative to an inactive lifestyle. This proposal was made at a

time when video games and television watching often replaced physical activity. Playing computer and video games are popular free-time activities among children and adolescents (Nippold, Duthie & Larson, 2005). These games play a prominent role in the culture of young people (Dorman, 1997). Playing electronic games has often met with skepticism. The negative consequences of electronic gaming on young children, as cited by Bale (1994) include tendon injuries and social introversion as seen in the promotion of aggressive behavior.

The potential benefits of electronic games as outlined in studies by Yawn et al. (2000); Lieberman (2001); Beale, Kato, Marin-Bowling, Guthrie and Cole, (2007) are as follows: (a) games can support interactive, experiential learning which can improve players' health-related self-efficacy and behavior; (b) games are particularly motivational for young people who may be difficult to influence through traditional physical activity interventions; (c) games can provide individualized feedback on health choices; (d) games can support progress at one's own pace; (e) games can offer opportunities for social interaction and health-related social support both within the game and around it which can enhance players' motivation to improve health behaviors; and (f) games can offer unlimited opportunities to rehearse self-care skills which may favor the transfer of those skills to real-life situations. This supports the assertion by Dalleck, Bausch, Beran, Cahanes and Krug (2008) that exergames may constitute ideal vehicles for promoting regular physical activity among children who may be reluctant to participate in traditional types of exercise.

Furthermore, findings by Green et al. (2003) suggest that, as a player's exergame proficiency increases through practice and enjoyment, health benefits are increased.

Problem Statement

Following a search for articles pertaining to the influence of exergaming on physical activity, it has been concluded that there are a limited amount of empirical studies to support the effectiveness of exergames and that research has thus far been limited to dance simulation video games, which are mostly based on small samples and assessments of the short-term effects of exergames. Researchers recommend that further empirical investigation is needed with special focus on populations most in need of exercise (e.g. youngsters who are overweight or exhibit low fitness levels and aversion towards physical exercise) and on the impact of exergames on

physical, social and emotional outcomes. The rapidly growing rate of childhood obesity makes it imperative to develop an effective intervention program for obese children.

Aims of the Study

The main aim of this study was an attempt to answer the question as to whether and how the power of electronic games can drive overweight and obese children towards adopting a healthier lifestyle, becoming more physically active in daily life and improving their self-concept.

Hypotheses

Research hypothesis 1. Participating in a 6-week exergaming program will improve physical fitness as well as positively influencing attitude towards physical activity and self-concept in overweight and obese children.

Research hypothesis 2. A 6-week traditional video gaming program will improve physical fitness as well as positively influencing attitude towards physical activity and self-concept in overweight and obese children.

Research hypothesis 3. Physical fitness, attitude towards physical activity and self-concept will improve in overweight and obese children over a period of 6-weeks.

Null hypothesis 1. A 6-week exergaming program will have no effect on physical fitness, attitude towards physical activity and self-concept in overweight and obese children.

Null hypothesis 2. A 6-week traditional video gaming program will have no effect on physical fitness, attitude towards physical activity and self-concept in overweight and obese children.

Null hypothesis 3. There will be no improvements in physical fitness, attitude towards physical activity and self-concept in overweight and obese children over a period of 6-weeks.

Delimitation

This study is limited to overweight and obese subjects selected within a 20 km radius of the University of Zululand. The duration and frequency of the intervention program may constrain results as subjects only had access to the intervention program for 5 days a week between 14h00 and 16h00 for 6-weeks. The questionnaire used in this study limits other variables contributing to individual self-concept and attitude towards physical activity.

Limitation

Both physical and psychological maturation follow predictable time lines, indicating that the improvement in results might be explained by time. External factors in the subject's everyday life cannot be controlled.

Operational Definitions of Terminology

Fitness. For the purposes of this study, fitness was categorized into health-related fitness and functional fitness both being dependent on the other (Hastad & Lacy; 1998).

Health-related fitness. Health-related fitness includes cardiovascular endurance, muscular strength and endurance, body composition, flexibility. It focuses on factors that improve optimum health and reduces the risk of diseases and health problems associated with physical inactivity (Hastad & Lacy; 1998).

Functional fitness. Functional fitness includes the components of agility, speed, coordination, power, reaction time and balance. It focuses on building a body capable of doing real life activities that replicate the movements found in daily life such as lifting, throwing, catching and pushing (Hastad & Lacy; 1998).

Physical activity. There appears to be no consistent operational definition for physical activity. For this study physical activity will be defined as any bodily movement produced by skeletal muscles that results in an expenditure of energy (Deforche et al.; 2003).

Self-concept. Self-concept refers to all the opinions, feelings and beliefs that a person holds about himself or herself. Self-concept also refers to the measurable and observable knowledge a person has about himself or herself, including the awareness of the different abilities that make a person unique (Malina et al., 2004).

Child obesity. Child obesity is a condition where excess body fat negatively affects a child's health or wellbeing (Baechle & Earle; 2000).

Kinetic video game. A kinetic video game can be defined as a game that requires a computer to mediate game play. Activity is not defined by motions that specifically manipulate computer input devices but movement of body parts that are interpreted by the computer to have specified meanings (Exergaming, n.d.).

Exergaming. Exergaming is a term used for video games that also provide exercise. Exergaming has one element of exercise and one element of gaming (Exergaming, n.d.).

The Nintendo Wii. The Nintendo Wii is a game console that allows users to control a game using physical gestures using motion sensing technology (Exergaming, n.d.).

CHAPTER TWO

LITERATURE REVIEW

Obesity

Obesity can be classified as a chronic disease and like any other chronic disease great value is placed on primary prevention. Primary prevention comprises preventive measures that forestall the development of a disease. According to Rosenbaum and Leibel (1998) the most effective obesity prevention starts in childhood. The obesity epidemic reflects the numerous and complicated interactions between genetic, biological, psychological, sociocultural and environmental factors (American Academy of Pediatrics, 2003). Lobstein, Baur and Uauy (2004) identified the predictors of child obesity as: maternal nutrition during pregnancy; child's birth weight; breastfeeding; parental obesity; family socioeconomic conditions; child's dietary habits; and physical activity status. The last two predictors (dietary habits and physical activity status) can result in an unbalance between energy intake and energy output.

Interestingly, studies show that overweight individuals do not necessarily eat more, on the contrary, they often eat less or the same amount as normal weight individuals (McArdle et al., 2007). Decreased physical activity is what seems to play the central role in obesity (Nader, Bradley, Houts, McRitchie & O'Brien, 2008). The predictors most commonly found by research are discussed below.

Maternal nutrition during pregnancy. Goedecke, Jennings and Lambert (2006) reported that individuals exposed to food scarcity during the first and second trimesters of pregnancy were likely to be obese as young adults. Maternal nutrition seems to have a substantial influence on child health, Mattocks et al. (2008) go one step further by suggesting that mothers should be more active during pregnancy as physical activity during pregnancy predicts the child's physical activity level by the age of 11 and 12 years.

Birth weight. According to Ong and Dunger (2002), low birth weight may act as a predictor for the development of obesity in young adults. Previous researchers confirm the great probability of children born with a small mass becoming obese adults (Valdez, Athens, Thompson, Bradshaw

& Stern, 1994). Fisher et al. (2005) showed that premature babies are less active than their peers at age 7. Further evidence strengthens this in that premature babies are less coordinated which tends to follow a more sedentary lifestyle (Gaskins et al., 2010). Research has documented the explanatory mechanisms for low birth weight being a strong predictor for obesity, including lasting changes in proportions of fat and lean body mass, central nervous system appetite control and pancreatic structure and function (Stettler, Zembel, Kumanyika & Stallings, 2002).

Breastfeeding. Research has acknowledged the association between breastfeeding and lowered risk of childhood obesity (Gillman et al., 2001). Arenz, Ruckerl, Koletzko and von Kries (2004) displayed the critical role of breastfeeding in eating behavior later in life with meta-analysis showing that breastfeeding significantly reduced obesity in childhood. It has been suggested that breastfeeding may serve as protection against obesity in later life (Armstrong & Reilly, 2002). However, findings on this matter remain inconclusive. The association between breastfeeding and childhood obesity protection would appear to be tenuous when compared to other risk factors influencing child obesity such as socioeconomics (Dewey, 2003).

Parental obesity. Obesity has been identified as “running in the family” (American Academy of Pediatrics, 2003). Approximately 75% of body fat and total fat mass may be determined by the individual’s lifestyle with the remainder attributed to genetic factors (Bouchard, 1991). Sweeting (2008) reported a connection between weight and genetics; he explains that the connection is similar to the connection between height and genetics. Rosenbaum and Leibel (1998) agree that genetics contribute to childhood obesity but admit that research on genetic influences is limited. Rosenbaum and Leibel (1998) believe that genetics alone cannot explain the epidemic; they suggest that research should rather focus on environmental determinants that are sustainable.

Socioeconomic status. Research has documented that socioeconomic status is inversely related to the risk of obesity (Singh, Kogan, van Dyck & Siahpush, 2008). There is a body of evidence linking level of education to obesity. According to the South African demographic and health survey, black African women with low education status have a higher body mass index (Puoane et al., 2002). The survey also found that individuals with lower levels of education had incorrect

perceptions of their actual body weight. Strauss and Knight (1999) investigated the influence of home environment on the development of obesity in children. Results revealed a significant connection between low family income and obesity. A review by Sobal and Stunkard (1989) documents that one third of studies showed no relationship between socioeconomic status (SES) and obesity, the second third demonstrated increased obesity associated with low SES and the last third demonstrated increased obesity associated with high SES. Thus, the question whether SES influences obesity has yet to be answered. Moreover, the inconsistent indicators of obesity make it difficult to decide what interventions are appropriate.

Dietary habits and physical activity status. Researchers seem to believe that energy disturbance is the primary cause of increased rates of childhood obesity (Eliakim et al., 2002; Dodd, 2007). Total energy expenditure (TEE) is categorized into three components. The first is basal or resting metabolism rate (BMR) which refers to the energy requirements of basic physiological functions. BMR accounts for 60% of TEE. The second component is metabolic response to food which is energy required to digest and absorb food and makes up 10% of TEE. The third and only variable component which is physical activity (Levine, 2007). Energy required for any specific activity depends on body mass, muscle mass and type of activity. Exercise could contribute as much as 50% of TEE (Molnar & Livingstone, 2000). Hence increased physical activity appears to be the answer to the disease as it has an effect on body composition, boosts metabolism and leads to increased energy expenditure of which again aids weight loss (Nowicka & Flodmark, 2007). These findings are in line with previous studies where increased physical activity has been associated with lower body fat (O'Loughlin, Gray-Donald, Paradis & Meshefedjian, 2000; Moore et al., 2003).

Fortunately obesity predictors have led to preventions and interventions. A 2009 review on the effectiveness of interventions preventing childhood obesity (Summerbell et al., 2005) examined 22 studies; 10 long-term studies and 12 short-term. A combination of dietary education and physical activity served as interventions for the six long-term studies. No significant weight loss changes were found in five of these studies. One, however, showed improvements in girls but not boys. Two studies focused on physical activity alone. From these studies, a multimedia

approach seemed to be more effective. Nutrition education was looked at in the last two long-term studies with no success found in preventing obesity.

Four short-term studies increased physical activity among subjects and two studies showed minor reductions in weight loss. The other eight short-term studies focused on dietary advice and increased physical activity. None showed significant results. The authors of the review concluded that the designs of these interventions needed to be reconsidered alongside comprehensive reporting of the intervention scope and process. They also acknowledged the effectiveness of increasing physical activity and reducing sedentary behavior in the prevention of obesity. Despite the health-related benefits obtained in the above studies, maintenance of physical activity levels are seldom obtained. Researchers suggest that self-concept interventions may facilitate the attainment of appropriate body composition, health-related fitness, physical activity, exercise adherence and physical skills (Fox & Corbin, 1989; Marsh, 2002).

Self-concept

Self-concept is a multidimensional term that refers to an individual's perception of himself or herself in relation to his or her various characteristics. Self-concept is measured by self-assessments such as perception of one's skills and abilities, awareness of one's physical attributes, personality attributes and occupation and hobbies (Self-concept, n.d.). Previous studies show that the influences of obesity on mental health include depression, low self-esteem, poor body image and social isolation (Rowland, 1990). There is a growing body of research which indicates that self-concept and self-esteem are interchangeable terms (Franken, 1994). Huitt (2009) simplifies the two terms by defining self-concept as the term relating to the cognitive or thinking aspect of the self and self-esteem as the term relating to the affective or emotional aspect of the self. Self-esteem can be thought of as the balance between one's achievements and one's aspirations (James, 1890). It is either measured globally (e.g. 'I think that I am a great person') or in a specific domain (e.g. 'I think that I have a good body'). The global domain is seen as the core development of healthy psychology with the specific domain in this context referring to body image (Wardle & Cooke, 2005). Franken (1994) states that an individual with good self-esteem has a clear differentiated self-concept.

A review of 28 studies by Wardle and Cooke (2005) concluded that overweight and obese children, predominantly white girls, had lower global self-esteem compared to normal weight peers. These studies indicated a strong relationship between obesity and low self-esteem with scores obtained by the participants almost always falling into the average range of norms of conducted tests. Similar results were found by Strauss (2000), where 9 and 10 year old obese children demonstrated scores insignificantly different from their non-obese peers regarding scholastic and global self-esteem. A 4-year follow up study was conducted on these subjects. Results showed significantly decreased levels of global self-esteem among obese females and mild decreases in global self-esteem in obese boys. The researcher concluded that, by 13 and 14 years, obese subjects demonstrated lower levels of global self-esteem than their non-obese counterparts.

Self-esteem, body image and emotional wellbeing are the three aspects of psychological wellbeing that are generally compromised in obesity (Wardle and Cooke, 2005). Santos and Sawaia (2000) believe that good body image creates an internal equilibrium of wellness. Body image has been defined as a mental picture of the size, image and shape of the body that is influenced by historical, social, cultural, individual and biological factors (Slade, 1994).

Ricciardelli and McCabe (2001) found a relationship between body mass index and body dissatisfaction in children, particularly in girls. A cross-sectional study revealed that weight related teasing among 13-17 year old girls is a greater predictor of body dissatisfaction than the actual weight of a child (Van Den Berg, Wertheim, Thompson & Paxton, 2002). Eisenberg, Neumark-Sztainer and Story (2003) confirmed that weight teasing predicts body dissatisfaction across all weight categories and is also associated with the increase of suicide attempts. Wardle and Cooke (2005) proposed that body dissatisfaction is not inevitable, since half of overweight children are not aware that they are overweight and are therefore not dissatisfied with their bodies. Conversely, many normal weight and under-weight children also express body dissatisfaction (Fitzgibbon, Blackman & Avellone, 2000). Moreover, significantly increased rates of sadness, loneliness and nervousness were associated with the declined results found among obese children.

According to research, an individual's appearance and strength self-concepts have a direct effect on their global self-concept, whereas body fat does not have a direct effect on global

self-concept (Lau, Cheung & Ransdell, 2008). The latter study revealed that physical self-concept may not serve as a mediator with regard to modifying global appearance and strength self-concepts. This indicates that body appearance is beyond the sole notion of physical concept. Individual lifestyles, social relationships and daily behavior represent the modern society of body appearance (Parizkova & Hills, 2001).

Impaired physical appearance is the most obvious consequence of obesity associated with low self-esteem, social alienation and lack of self-confidence (Wabitsch, 2000). Fox (1999) reported that exercise may improve individual self-perception; this could contribute to the growing evidence that exercise increases mental wellbeing. Stigmatization and discrimination are common among overweight and obese individuals (Robertson & Vohora, 2008). Literature findings reported that average weight children had negative perceptions of their obese peers. In particular, obese children were perceived as less attractive, less athletic, having poor leadership skills and being more aggressive (Zeller, Reiter-Purtill & Ramey, 2008). According to Schwartz, Chambliss, Brownell, Blair and Billington (2003), weight stigmatization is associated with poor psychological adjustment, which serves as a potential barrier to the engagement in a healthier lifestyle. Latner and Stunkard (2003) conducted a study in which children ranked drawings of obese and healthy children. The results revealed that the drawings of obese children were ranked significantly lower than the other drawings. A more recent study documented similar results where obese children were found to be less accepted by peers than normal weight peers (Zeller et al., 2008). Furthermore, it appears that overweight children have fewer friends and relationships (Eisenberg et al., 2003).

Fox (1999) reported that children with high levels of physical activity are less likely to experience anxiety and depression. Interestingly, Marsh and Peart (1988) noticed that physical intervention is limited to physical self-concept and has no relationship with nonphysical self-concept.

Attitude towards Physical Activity

Attitude represents positive or negative views of a specific activity, person or place. It is a changeable judgment established by experience and observational learning from significant others (Attitude Psychology, n.d.). Significant others may include family members, peers, school

friends, media personalities and sports heroes. Family is the source of primary significance. This emphasizes the importance of the role of parenting in whether a child is physical active or not.

Research has found that the level of parental encouragement predicts activity levels in children (Biddle & Goudas, 1996). According to Wadden and Stunkard (2002), weight loss interventions are far more effective regarding short- and long-term weight loss if there is parental involvement. Many studies have provided evidence that enjoyment is the utmost predictor of physical activity participation (Stucky-Ropp & DiLorenzo, 1993; DiLorenzo, Stucky-Ropp, Vander Wal & Gotham, 1998). This places great emphasis on the satisfaction children perceive from physical activity when considering any intervention relating to increased physical activity levels.

Human behavior is heavily influenced by the interaction of the social and physical environment (Stokols, 1996). This implies that one's environment has an impact on whether or not one engages in physical activity. The shocking rates of victimization and discrimination against obese individuals do not encourage their participation in physical activity and contrary evidence shows that peer rejection places children at risk for psychological maladjustment (Deater-Deckard, 2001). Rhodes, Courneya and Jones (2004) foresee prior behavior as an indicator for future behavior. Thus, inactive children tend to become inactive adults exposing themselves to cardiovascular disease, obesity, hypertension, type 2 diabetes, osteoporosis and several psychological disorders. This suggests that engagement in physical activity should be encouraged at a very young age to produce a long-term lifestyle based on high levels of physical activity (Warburton et al., 2007).

Medical experts agree that increased physical activity is a vital aspect of an intervention program as it maintains fitness, reduces weight and improves health, yet many people have difficulty in taking part in regular physical activity. Physical activity involves fundamental skills dependent on environmental influences in the form of practice, learning and teaching. Numerous research findings have indicated a positive relationship between an individual's perception of his or her physical activity competence and degree of participation (Sung, 2005). This could explain the typical scenario of the child with a high perception of his or her physical activity competence and an eagerness to participate and perform in sport while the child with a poor perception of his or her physical activity competence, will not willingly take part in sport. A vicious circle is

formed with lack of physical education in school curriculums preventing full development of fundamental skills. Insufficient development of physical activity competence leads to obese children who in turn avoid physical activity.

Boreham and Riddoch (2001) review human beings as species specifically designed to move. From this perspective physical activity appears the most practical measure to follow when either preventing or intervening with obesity or other health risks. According to Ajzen and Fishbein (1980), attitude towards physical activity is a useful tool when predicting participation. Becker and Maiman (1975) proposed that attitude towards physical activity may be determined by the individual weighing of benefits and barriers. When more benefits are perceived, the individual is likely to have a positive attitude towards physical activity and participation will be high. However, an individual who perceives more barriers than benefits is unlikely to take part in physical activities.

Deforche, De Bourdeaudhuij and Tanghe (2006) conducted a study in Belgium investigating the benefits of and barriers to physical activity as perceived by 90 adolescents randomly recruited to a normal weight group, an overweight group and an obese group. Results were obtained via a questionnaire subdivided by several benefits of and barriers to physical activity. The benefits included social contact, pleasure, competition, feeling better, looking better, losing weight, improving health and physical conditions. The barriers included insecurity about appearance, not being good at it, not liking it, physical complaints and external barriers. The questionnaire was scored on a 5 point Likert scale (from 1 = strongly disagree to 5 = strongly agree). Results showed no difference among the groups in mean perceived benefits, only in mean perceived barriers. Subtracting the mean perceived benefits from the mean perceived barriers revealed that obese subjects showed a less positive attitude toward physical activity than their normal weight and overweight counterparts. However, Deforche et al. (2006) also found that the three groups showed no difference in their perceptions of leisure physical activities. Furthermore, Zabinski et al. (2003) reported that overweight children aged between 8-16 years perceived significantly higher barriers against physical activity compared to their normal weight peers. These included social- and body-related barriers, the latter being more predominant. A less positive attitude toward physical activity among obese children may be explained by their low self-concept in physical activities. In addition to these findings, Zabinski,

Saelens, Stein, Hayden-Wade and Wilfley (2003) also documented lower levels of adult support for physical activity among overweight subjects. Tones and Tilford (2001) recommend taking full advantage of the school environment by using it as a health promoting setting where health-related beliefs, behaviors and attitudes can be established from a young age. Physical activity is linked to increased brain function, higher energy/concentration levels and increased self-esteem (Cocke, 2002).

Fitness

Martinez-Vizcaino and Sanchez-Lopez (2008) define physical activity as behavior and physical fitness as a state that is a result of both genetic conditioning and individual determinants. Rice and Howell (2000) proposed the term physical activity as the process for achieving physical fitness. Previous research suggests that active behavior should be promoted to modify the level of physical fitness since modifying genetic determinants is unattainable (Martinez-Vizcaino & Sanchez-Lopez, 2008). Good physical fitness and regular physical activity contribute to optimal health and wellness. Health is the state of being associated with freedom from disease and illness, whereas wellness takes into account the integration of mental, social, emotional, spiritual and physical aspects. Physical health relates to good physical fitness and confidence in one's personal ability to take care of health problems (Corbin & Lindsey, 1997).

Physical fitness is categorized into health- and functional fitness components. Health-related components include cardiovascular endurance, muscular and strength endurance, flexibility and body composition. Functional fitness components involve balance, agility, power, coordination, reaction time and speed (Corbin & Lindsey, 1997).

According to Steinbeck (2001), there is evidence linking physical inactivity to the development of obesity in children. Moreover, numerous diseases are related to physical inactivity, referred to as hypokinetic diseases. Hypokinetic conditions include cardiovascular diseases, cancer, back problems, obesity, diabetes, osteoporosis and mental illnesses (Corbin & Lindsey, 1997). Taken together, this information demonstrates the health and illness continuum shown in Figure 1.

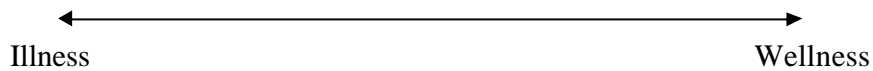


Figure 1. Health and Illness Continuum (Adapted by van Biljon, 2010).

On the illness side of the continuum, treatment is the vehicle towards wellness. In this case regular physical activity is considered as the treatment. Adolescents who perform 60 min of moderate-to-intense physical activity most days of the week have greater cardiovascular capacity (Ortega, Ruiz, Hurtig-Wennlof & Sjostrom, 2008). Cardiovascular fitness is also known as cardiorespiratory fitness, which is the ability of the body's circulatory and respiratory systems to supply fuel and oxygen during continuous physical activity. Maximal volume of oxygen consumption (VO_2 max) is considered the best measurement of cardiorespiratory fitness (Ortega et al., 2008). Obesity does not necessarily predict impaired cardiorespiratory fitness. A study conducted by Cooper, Poage, Barstow and Springer (1990) revealed that increased body mass and age have no effect on unloaded exercise. However, as exercise progressed the relationship between VO_2 max and body mass was distorted in obese subjects. This may indicate a tougher workout for obese subjects. Despite the distortion of VO_2 max, the responses of obese subjects were in normal ranges. The study concluded that child obesity is a poor indicator of impaired fitness but that testing cardiorespiratory responses to exercise can be used to identify and treat individuals with impairments. Regardless of these results, obese individuals tend to believe they are unfit and lack coordination (Focht & Hausenblas, 2004).

A study conducted in Portugal found that overweight and obese girls aged between 8 and 9 years had significantly lower cardiorespiratory fitness. Therefore overweight and obese girls were likely to be unfit (Mota, Flores, Ribeiro & Santos, 2006). Rowland (1990) also noticed the significant association between cardiorespiratory fitness and fatness. Psarra, Nassis and Sidossis (2005) concluded that children with a high waist circumference and low cardiorespiratory fitness are expected to be obese. Cross-sectional studies showed an inverse relationship between physical activity and body mass (Strazzulo et al., 1988). Obese adolescents tend to be less physically fit than their leaner counterparts (Deforche et al., 2003). The latter study suggests that negative associations between physical fitness and adiposity in some studies may be due to physical activity expressed as absolute energy expenditure. Bar-Or and Baranowski (1994)

recommend that physical activity should be expressed as body movement rather than energy expended.

Mota et al. (2006) demonstrated a correlation between body mass index and cardiorespiratory fitness in girls aged 8 and 9 years. A high body mass index predicted low cardiorespiratory fitness in the girl subjects. Accordingly, the data in this study indicates that overweight and obese girls are likely to be unfit. However, there was no such relationship among boys. Mota et al. (2006) reported that the reason for this may be the small number of subjects. Kim et al. (2005) support these findings with their longitudinal study that showed significant association with cardiorespiratory fitness predicting girls to be overweight. Conversely, Kamtsios and Digelidis (2007) reported that overweight and obese girls and boys performed less well in the Eurofit physical fitness test battery which covers flexibility, speed, endurance and strength. More specifically, they performed poorly in long jump and in the 30 m speed and 20 m shuttle run. Nevertheless, according to Boreham et al. (2001) there is a strong link between cardiovascular fitness and fatness among children. Boreham and Riddoch (2001) suggest that, when trying to improve a child's health, one should increase fitness and reduce fatness. This again suggests that health interventions should increase physical activity and involve diet control programs.

Deforche et al. (2003) confirmed that obese children have inferior cardiovascular fitness levels. This may be because, as, Kamtsios and Digelidis (2007) reported, obese children prefer sedentary activities to physical activities. Excess fat contributes to lower physical fitness performance as it is extra weight for children to carry, implying that additional energy is required when performing the same activity as their normal weight peers. It is known that regular physical activity allows the development of physical and psychological skills in children (Bekker & Eggen, 2008). Consequently, a lack of experience may discourage participation in physical activities (Kamtsios & Digelidis, 2007). Rowlands, Eston and Ingeledew (1999) support a positive relationship between activity and fitness. Moreover, Rowlands et al. (1999) concluded that obese children are inactive with no interest to exercise. A study conducted in Greece on children's daily locomotive habits revealed that obese children watched more television during weekdays and weekends than their non-obese counterparts (Kamtsios & Digelidis, 2007).

Exergaming

The most common sedentary activities among children include watching television and playing video games. The American Academy of Pediatrics (2001) indicated in a study that children spend a minimum of 3 hours per day watching television. Pratchett (2005) reported that 75% of UK children and adolescents play three to seven 1.9 hour sessions of video gaming per week. These findings suggest that television and video games are fast replacing physical activity in recreation. Vandewater, Shim and Caplovitz (2004) concluded that playing video games was related to a high body mass index, whereas television viewing had no relation to children's weight status. The results in this study showed that moderate amounts of electronic games were played by children with a higher body mass index, while children with a lower body mass index either played very little or a lot of electronic games, thus providing both a linear and curvilinear relationship between electronic games and weight status. Taken together, the data collected suggested that screen time encourages sedentary lifestyles among young children, therefore contributing to the high occurrences of obesity in children.

The link between video games and obesity collapsed when Segal and Dietz (1991) conducted a study on the physiological responses to playing a video game. Scores showed a similar magnitude of increased metabolic rate and cardiovascular stimulation when playing an inactive video game while standing or when taking part in mild intensity exercise. The study validated the fact that video games are not sedentary activities and cannot therefore be associated with obesity. A more recent study done by Wang and Perry (2006) strengthens Segal and Dietz's (1991) allegation. Participants in this study were 7-10 year old boys who illustrated significant increases in heart rate, blood pressure, ventilation, respiratory rate, oxygen consumption and energy expenditure when playing an action video game. However, Wang and Perry (2006) stressed that video games should not replace physical activity since scores showed that the magnitude of changes was not comparable to standard exercise. On the other hand, if video games were substituted for television viewing they could lead to higher energy expenditure.

Exergaming is a combined word formed from the words exercise and gaming. This term is used to describe video games that encourage physical activity (Health Benefits of Gaming, 2008). As early as 1982 attempts were being made to develop interactive video games, yet none of these attempts were acknowledged by the market mainly due to costs. In 1998 Konami

introduced the Dance Dance Revolution (DDR), a virtual dancing game outlined with a series of steps combined with upbeat music performed on a floor mat with built-in sensors. The DDR proved its success when Norway registered it as an official sport (Exergaming, n.d.). Eye toy was then released in 2003 where the user's physical movements are used to control the game through an image sensor camera. The technology does not restrict interaction through motion but allows color and sound interaction.

Bianchi-Berthouze, Kim and Darshak (2007) reported that involving body movements to control a video game increases the gamers' level of engagement. In 2006 Gamercize combined traditional fitness equipment with game consoles. In the same year Nintendo Wii Sports was launched as the next major exergame with remarkable commercial success as it not only entertains the user but also provides game challenges, pleasurable exercise, sport concepts, daily fitness assessments and more than one player so that it can evolve into a social event (Dasgupta et al., 2007). Nintendo Wii Sports is a motion-sensing exergame consisting of five different sports (tennis, golf, boxing, bowling and baseball) which allows real life sport actions, such as tossing, swinging and punching, through the Wii remote. In 2007 Nintendo released Wii Fit, a game designed to act as one's own virtual personal trainer where one can choose from a variety of exercises (balancing, aerobic and strength).

According to sales figures Wii has become the market leader in home consoles. Wii Fit has sold over 21 million copies (Exergaming, n.d.). The term exergaming entered the Collins English Dictionary in 2007. Of all the exergames, Wii appears to be the most widely distributed movement-based game console (Graves, Ridgers & Stratton, 2008) unfortunately injuries from playing Wii have been reported in the media, diagnosed as Wii shoulder. Powell (2008) speculates that gamers could not recognize Wii as a sport device and thus, consequently could not see the need to warm-up before playing.

A study in Hong Kong compared children's energy expenditure and cardiovascular responses in a seated screen environment and in active gaming. Subjects playing active games revealed an increase heart rate of 20-79 beats per minute. With regard to calories burned, the seated game burned 39%, an active bowling game 98% and a running game 451%. These exceptional results validate the notion of new generation active computer games as an opportunity to increase children's physical activity with appealing alternatives (Mellecker &

McManus, 2008). Lanningham-Foster et al. (2006) reported that playing sedentary computer games increases resting energy expenditure by 22% with active video games, resting energy expenditure increased by 40% and 68% for EyeToy and Dance Dance Revolution respectively. With such encouraging results Lanningham-Foster et al. (2006) encourages parents to consider active screen time for their children rather than sedentary screen time as energy expenditure is more than doubled.

Graves, Stratton, Ridgers and Cable (2007) found significant results when comparing the energy expenditure of adolescents when playing Xbox (sedentary video game) and Wii Sports (exergame). The energy expenditure for Wii Sports was 65.1kJ/kg/min greater than for the sedentary video game. Graf, Pratt, Hester and Short (2009) compared active video gaming to moderate intensity walking in terms of energy expenditure as results in this study indicated that rates of energy expenditure, heart rate and perceived exertion were similar when playing Wii boxing, Dance Dance Revolution level 2, or when walking at 5.7 km/h. These results are supported by Mhurchu et al. (2008) who affirm the related energy expenditure of exergames and real physical activity. Despite these captivating results, Willems and Bond (2009) disapproved of substituting moderate intensity exercise with Wii Sports since results in their study revealed that energy expenditure during a brisk walk on a treadmill is significantly higher than when playing Wii Sports tennis, baseball or boxing. Wii Sport boxing showed higher metabolic equivalents than Wii Sports tennis and baseball. Willems and Bond (2009) advised using Wii Sport boxing as a guide to the required physical activity. However, playing a combination of Wii Sports may not serve as a substitute for a program promoting health. Ridley and Olds (2001) investigated energy expended during video game play in 11 and 12 year old children and found that the magnitude of energy expenditure is related to the amount of body movement.

Pasch, Bianchi-Berthouze, van Dijk and Nijholt (2009) claimed that active video games promote unique movements in individual players as each player responds with different movements. The study outlined the motivations and strategies of active video gamers followed by the related movements during Nintendo Wii boxing. Data revealed that “achieving” and “relaxing” were the two different motivations when approaching Wii boxing. The corresponding strategies were identified as “game” and “simulation” respectively. Researchers then recorded players’ movement patterns by means of a motion capture suit. This was done to draw a link

between the movement patterns and the players' specific strategies. Participants with an "achieving" motivation were driven by the "game" strategy. Two movement patterns were associated with these traits. The first showed few extensions of the arms but high punching frequency. Pasch et al. (2009) clarify this by stating that these gamers have learned that the punch amplitude is irrelevant and that a short impulse is enough to perform a punch. The behavior among these subjects showed low emotional engagement and low physical activity. The second movement pattern reflected subjects with the same "game" strategy with high physical activity through bigger arm extensions and high punch frequency. Participants who wanted to relax approached the "simulation" strategy that has fewer punches with bigger arm extensions. The movement patterns they reflected appear to imitate real life boxing and medium levels of physical activity were perceived. Researchers concluded that, as gamers gain expertise in a game their behavior changes in terms of motivation, strategy and movement patterns. Pasch et al. (2009) configured that, as a player's exergame proficiency increases through practice, enjoyment and health benefits increase as well.

A study in South Australia found that the Wii Fitt jogging game had subjects more involved in energy, facial expression, posture and persistence than traditional running games (Geng, 2009). However, there were no significant differences found in concentration, complexity, creativity, precision, reaction time, verbal utterances or satisfaction.

Mhurchu et al. (2008) documented encouraging results towards weight and waist circumference within a 12-week active video game intervention program. The mean difference in body mass was -0.13 kg along with a -1.4 cm mean difference in waist circumference. However, Madsen, Yen, Wlasiuk, Newman and Lustig (2007) found that, on the contrary exergaming had no relation to change in body mass index in overweight young people.

A study in Canada implied that interactive video games are a greater promoter of physical activity than traditional exercise, as participants in the interactive video game intervention attended 30% more frequently than participants in the traditional training group. Results in this study showed that neither the 6-week interactive video game training nor the traditional exercise training program caused any significant changes in body composition. However, the interactive video games significantly increased participants' VO_2 max and reduced their resting systolic blood pressure more than the traditional training program (Warburton et al., 2007). This study

proposed that interactive video games may be useful in the battle against physical inactivity and associated health risks given the mass appeal of video games among children. Paw, Jacobs, Vaessen, Titze and van Mechelen (2008) support this proposition by revealing that children aged between 9-12 years prefer multi-player and group game play to individual and traditional exercises.

Modern video games have proved to encourage physical activity and are seen by researchers as a contingency strategy for sedentary behavior (Faith et al., 2001). However, Goldfield et al. (2000) found that this contingent management strategy is not fit for the real world as subjects engaged in their preferred sedentary behavior instead of the contingency exercise plan when left unsupervised.

Warburton et al. (2007) proposed an adherence physical activity training program by integrating the attractive properties of sedentary activities into the physical activity experience. The reinforcing stimulus is thus the experience of physical activity itself. In a 5-month exergame study, objective to increase third and fourth grade physical activity levels, Chamberlin and Gallagher (2008) revealed that, according to the teachers, 85% of “at risk” students developed social skills, enthusiasm for sports, fitness and dance. School attendance climbed by more than 50% and 94% of students increased in leadership skills and confidence which, in turn, increased self-esteem and academic performance.

Ecological System Theory

This study is a model of behavior change emphasizing individual and environmental factors as well as the interaction between both individual and environment (Odum, 1971). These factors or constraints can powerfully shape human action and behavior (Haywood & Getchell, 2005). The constraints of the ecological system theory are displayed in Figure 2.

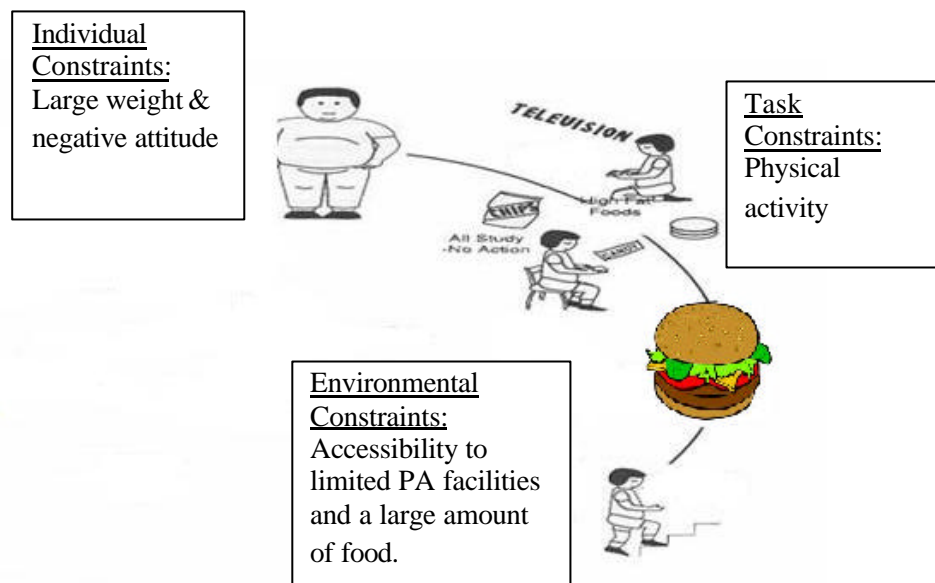


Figure 2. Ecological System Theory Model (Adapted by van Biljon, 2010).

Individual constraints. Individual constraints refer to the structural and functional characteristics of the individual, such as weight, attitude and motivation. Large weight and negative attitude towards physical activity are some of the characteristics shared among participants in this study. Zabinski et al. (2003) reported that overweight children displayed much greater resistance to physical activity which clarifies overweight children's inferior motivation levels.

Environmental constraints. Environmental constraints are classified into physical and sociocultural constraints. Physical constraints relate to the physical characteristics of the environment such as accessibility to physical activity and food. Modern life presents many of us with easy access to plenty of food while ironically, physical activity is limited and rare (Jirage, 2008). Sociocultural constraints include social variables such as family and peer support. Research reported low levels of support from both family and peers in overweight children (Biddle & Goudas, 1996). This study demonstrates a health-promoting environment by providing access to the Nintendo Wii.

Task constraints. Task constraints focus on the function and the goal of the task. This involves the specific movement to be executed to reach the goal and refers to game success. In this study, participation is the vehicle towards game success. This then places physical activity as the task constraint.

Summary

When all constraints are considered holistically constructive change is possible. The underlying concept of the ecological theory is that the most effective interventions occur on multiple levels. A system-based intervention is therefore needed to facilitate fitness and improve attitudes towards physical activity and self-concept in obese children (Swinburn, Figger & Raza, 1999). Exergaming, viewed from an ecological system theory, may contribute to children's daily energy expenditure as well as promote and improve physical activity levels (Daley, 2009). By enhancing physical activity levels, attitude and self-esteem will also be enhanced.

CHAPTER THREE

METHODOLOGY

Participants

A convenience sample of 30 overweight and obese children between the ages of 9-12 years old within a 20 km radius of the University of Zululand participated in this study. The terms overweight and obese as used in this study were defined by the gender- and age-specific growth charts developed by the National Center for Health Statistics. This indicates that a body mass index above the 85th percentile classifies a child as overweight and a body mass index above the 90th percentile classifies a child as obese (Cole et al., 2000). Subjects were recruited into 1 of 3 groups (intervention group, control group A and control group B) according to their location. The mean ages for the intervention group, control group A and control group B were 11,5; 11,2 and 11,5 respectively. Subjects received an individual logbook (see Appendix G) wherein the duration and the attendance of the 6-week exergaming program were recorded. A questionnaire was attached to all logbooks with the purpose of measuring subjective impressions and motivations, as well as the researcher's observations and remarks.

Experimental conditions

Intervention group. Participants in the intervention group were subjected to a 6-week intervention program which granted them access to the Nintendo Wii Sport and Wii Fitt between the hours of 14h00 and 16h00 at the University of Zululand. Participation entailed a minimum frequency of 3 days per week for a duration of 30 min per session. None of the participants had previously experienced the Nintendo Wii games.

Control group A. Participants in control group A had access to traditional video games. The same procedures and requirements were followed for this group as with the intervention group.

Control group B. Participants in control group B had no access to either Nintendo Wii games or traditional video games but continued with their everyday life without any intervention.

Procedure of the Study

Schools within a 20 km radius of the University of Zululand were approached by means of a 5-10 min presentation with flyers outlining the nature of the study. Interested pupils received a corresponding explanatory letter with a consent form.

Table 1
Test Battery (see Appendix C, D, E and F for full description)

| MEASUREMENT | PROTOCOL |
|------------------------------------|---|
| A. Health-related Fitness | |
| Body Composition | Stature Body Mass Waist-to-hip Ratio Skinfold Measurements |
| Cardiovascular Endurance | PACER Test |
| Blood Pressure | Sphygmomanometer |
| Resting Heart Rate | Heart Rate Monitor |
| Muscular Endurance | Push-up Test |
| Muscular Strength | Dynamometer |
| Flexibility | Sit-and-Reach Test |
| B. Functional Fitness | |
| Speed and Agility | Running Speed and Agility |
| Balance | Standing on Preferred Leg |
| Coordination | Catching a Tossed Ball with Preferred Hand |
| Reaction Time | Response Speed |
| C. Psychological Factors | |
| Attitude towards Physical Activity | Closed-ended Interview |
| Self-concept | The Cratty Self-concept Scale |

Baseline. Once the University of Zululand ethics committee had approved the study and all consent forms had been gathered, potential subjects were requested to assemble at the university

after school hours and take part in three consecutive days of pre-test assessments. All subjects were barefoot and wearing sports gear. The pre-test assessments were carefully arranged over three days according to the degree of intensity, thus preventing fatigue and ensuring accurate data. Trained personnel obtained anthropometric measurements. Personnel ran the same stations throughout the study. All subjects were given the same instructions and were treated equally.

Intervention program. The intervention program was conducted at the University of Zululand in the department of Biokinetics and Sport Science's Kinderkinetic laboratory. The program took place over a 6-week period requiring a minimum participation of 3 days per week for 30 min per session. Subjects were primed by an introductory class of Nintendo Wii games before the intervention program began to help participants feel at ease and comfortable. On the first day of the intervention program individual profiles were created for subjects by means of designing Mii game characters. Players create their own Miis which they physically manipulate by using gross motor movements. Participants were instructed to play the given Wii game at the specific station.



Figure 3. Example of Mii Character.

The intervention program operated in two stations that involved two aerobic games, boxing and hoola hoops. Participants were required to play for 15 min period at each station. Additional games were staggered throughout the intervention program on the last day of the week to maintain interest and prevent dropouts.



Figure 4. Experimental Group Playing on the Nintendo Wii.

Post-test. The post-test was conducted directly after the intervention program over three consecutive days on all groups. The post-test followed the same procedures as the pre-test.

Post-post-test. The post-post-test was conducted three weeks after the post-test to determine any retention in subjects' scores. This verified the intervention program's long-term effects.

Instruments

Standard equipment used in this study comprised four data projectors and four Wii consoles (including sport package and Wii Fit). Nintendo Wii was used as it appeared to be the most widely distributed movement-based game console (Graves et al., 2008).



Figure 5. Standard Equipment used in Study.

Data Analysis

Descriptive data was collected followed by inferential statistics using repeated measuring. The reason for choice was that one independent variable that represents 2 levels (Nintendo Wii Games and Traditional Games) was manipulated in this study. This model evaluated the null hypothesis between the three groups' means at a specific level of probability. This was followed with the rejection or acceptance of the null hypothesis. Effect sizes were calculated to assess the significance of the differences in fitness performance.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The results are discussed in tabular and graphic form according to the three research hypotheses used in this study. The characterized variables of the hypotheses are as follows: (a) physical fitness; (b) self-concept; and (c) attitude towards physical activity. The three assessments that have been conducted in this study are compared in each group. Thereafter a comparison between the groups is shown. Friedman's ANOVA and Kendall's Coefficient of Concordance statistics were used for multiple dependent variables. Values were expressed as means and standard deviation. The null hypothesis may be rejected when $p < 0.05$ and would be considered as significant.

The first research hypothesis states that physical fitness will improve in overweight and obese children who play exergaming. Physical fitness is demonstrated in two sections, namely, health-related fitness and functional fitness.

Health-related Fitness Results

Table 2 outlines the health-related fitness results found among the research groups. These results are discussed separately.

Table 2
Group Comparison Mean Scores and Standard Deviation on Health-related Fitness

| Health-related Fitness Protocols | | CONTROL A (Mean Age = 11.2) | | CONTROL B (Mean Age = 11.5) | | EXPERIMENTAL (Mean Age = 11.5) | |
|----------------------------------|--------|--------------------------------|-------|--------------------------------|-------|-----------------------------------|-------|
| | | Mean | SD | Mean | SD | Mean | SD |
| BM | PRE | 71.2 | 20.02 | 61.1 | 11.95 | 51.14 | 9.07 |
| | POST | *72.35 | 20.45 | *63.2 | 12.4 | *52.86 | 7.85 |
| | P.POST | 53.3 | 41.24 | 52.6 | 30.04 | *53.72 | 8.35 |
| WHR | PRE | 0.88 | 0.05 | 0.83 | 0.06 | 0.81 | 0.05 |
| | POST | 0.77 | 0.27 | 0.82 | 0.06 | 0.81 | 0.06 |
| | P.POST | 0.6 | 0.42 | 0.66 | 0.35 | *0.86 | 0.19 |
| Fat % | PRE | 103.3 | 24.92 | 97.2 | 24.43 | 72.36 | 16.12 |
| | POST | 95.1 | 19.56 | 90.5 | 16.1 | *86.27 | 16.48 |
| | P.POST | 68.7 | 51.36 | 72.3 | 40.46 | 82.55 | 18.11 |
| SBP | PRE | 119.6 | 13.6 | *118.3 | 7.73 | 114.45 | 19.89 |
| | POST | 117.8 | 9.65 | 120.7 | 5.33 | 113 | 13.93 |
| | P.POST | 81.1 | 56.35 | 94.3 | 50.15 | 105.64 | 7.84 |
| DBP | PRE | 77.33 | 10.44 | 69 | 5.68 | 60.18 | 13.11 |
| | POST | 73.5 | 7.84 | *77.6 | 15.45 | *76 | 15.46 |
| | P.POST | 49 | 34.54 | 55.4 | 30.01 | 68.09 | 6.09 |
| RHR | PRE | 90.6 | 16.39 | 90.8 | 15.09 | 101.45 | 11.35 |
| | POST | 85.2 | 15.7 | 81 | 12.34 | 99.91 | 18.3 |
| | P.POST | 58.6 | 41.33 | 67.3 | 39.42 | 94.36 | 12.78 |
| M. Endurance | PRE | 12.7 | 8.29 | 15.1 | 7.48 | 16.27 | 10.89 |
| | POST | *18.8 | 10.61 | *15.9 | 7.43 | *19.55 | 5.07 |
| | P.POST | 17.6 | 16.26 | 15 | 9.71 | *20.73 | 6.39 |
| M. Strength L | PRE | 18.9 | 5.03 | 15 | 3.51 | 13.36 | 4.2 |
| | POST | *19.3 | 6.69 | 14.55 | 3.8 | 13 | 3.53 |
| | P.POST | 13.65 | 11.1 | 12.5 | 7.25 | *14.18 | 3.54 |
| M. Strength R | PRE | 18.05 | 8.13 | 15.3 | 4.04 | 14.09 | 3.56 |
| | POST | *18.9 | 7.49 | 14.95 | 4.26 | *14.18 | 3.32 |
| | P.POST | 12.7 | 10 | 12.6 | 7.47 | 14.18 | 3.22 |
| Flexibility | PRE | 29.7 | 7.62 | 33.6 | 7.28 | 44.73 | 4.82 |
| | POST | *33 | 9.6 | 32.3 | 7.7 | 42 | 5.83 |
| | P.POST | 20.8 | 15.65 | 28.3 | 16.8 | *44.27 | 4.03 |
| Cardiovascular Endurance | PRE | 2.76 | 1.23 | 4.24 | 1.51 | 3.27 | 0.91 |
| | POST | *2.9 | 0.86 | 3.29 | 1.82 | 3.01 | 0.97 |
| | P.POST | 1.89 | 1.33 | 2.42 | 1.8 | 3.2 | 1.18 |

* Indicates items that increased

Experimental group results. All 11 participants in the experimental group took part in the three assessments conducted in the study. The active participation level may be ascribed to the rewards (T-shirts and certificates) offered for the completion of the research study. Table 3 displays the experimental group's mean and standard deviation on health-related fitness.

Table 3
Experimental Group Mean Scores and Standard Deviation on Health-related Fitness

| Health-related Fitness Protocols | EXPERIMENTAL GROUP | | | | | |
|----------------------------------|--------------------|-------|--------|-------|--------|-------|
| | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| BM | 51.14 | 9.07 | *52.86 | 7.85 | *53.72 | 8.35 |
| WHR | 0.81 | 0.05 | 0.81 | 0.06 | *0.86 | 0.19 |
| Fat % | 72.36 | 16.12 | *86.27 | 16.48 | 82.55 | 18.11 |
| SBP | 114.45 | 19.89 | 113 | 13.93 | 105.64 | 7.84 |
| DBP | 60.18 | 13.11 | *76 | 15.46 | 68.09 | 6.09 |
| RHR | 101.45 | 11.35 | 99.91 | 18.3 | 94.36 | 12.78 |
| M. Endurance | 16.27 | 10.89 | *19.55 | 5.07 | *20.73 | 6.39 |
| M. Strength L | 13.36 | 4.2 | 13 | 3.53 | *14.18 | 3.54 |
| M. Strength R | 14.09 | 3.56 | *14.18 | 3.32 | 14.18 | 3.22 |
| Flexibility | 44.73 | 4.82 | 42 | 5.83 | *44.27 | 4.03 |
| Cardiovascular Endurance | 3.27 | 0.91 | 3.01 | 0.97 | *3.2 | 1.18 |

* Indicates items that increased

The data reveal an increase in subjects' body mass, fat percentage, waist-to-hip ratio, diastolic blood pressure and muscular strength. Decreased values are seen in subjects' systolic blood pressure, resting heart rate, flexibility and cardiovascular endurance. The experimental group's values are displayed graphically in Figure 6. None of the values above indicates a significant difference. Hence, the null hypothesis for health-related fitness may be accepted. The insignificant differences associated with health-related fitness in the experimental group may be ascribed to a number of factors.

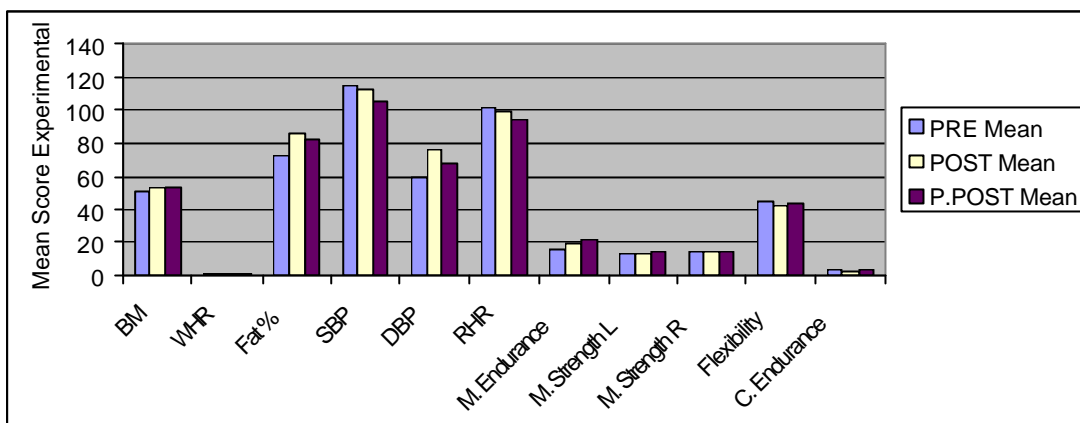


Figure 6. Experimental Mean Scores on Health-related Fitness.

Height and body mass increase linearly with age during childhood with the growth spurt one of the main factors to be considered. Growth spurt is a term used to explain rapid acceleration in height which starts on average between the ages of 9 and 10 years in girls and 11 and 12 years in boys. During maximum increase in height, girls may gain up to 7 kg of fat free mass. Boys gain double this mass. The subjects used in this study were aged between 9-12 years. Therefore, growth spurts may be responsible for increased body mass after the intervention program (Malina, 1999). Another research study reported to have found no changes in obese participants' body mass index after their dance dance revolution intervention program (Madsen et al., 2007). These findings are supported by Pettitt, Wollitzer and Jovanovic (2005) who reported insignificant differences in body mass after their 6-week exergaming intervention program.

During the intervention program it was observed how subjects arrived with astonishing amounts of unhealthy food, mainly large packets of chips, lollipops and boiled sweets. This continued throughout the program even when strongly discouraged by researcher and assistants and may, obviously, have contributed to increased body mass by the subjects.

Overweight and obese individuals are prone to hypertension (high blood pressure) as a result of excess fat accumulating inside arterial walls and increasing chances of a heart attack. The mean age of participants in the experimental group was 10 years and 4 months. According to the National Health and Nutrition Examination Survey conducted between the years 1999-2000, hypertension among children is defined as blood pressure levels at or above the 95th percentile

while blood pressure levels between the 90th and 95th percentiles are classified as a prehypertension state. Interval results revealed normal resting blood pressure values for all subjects. Resting heart rate may indicate a healthy heart and overall fitness level; a low resting heart rate is often associated with physical fitness because the heart works more economically. Figure 6 demonstrates the decrease in mean resting heart rate from first to last assessment. The experimental group included only one subject aged 9 years. So resting heart rate norms for children aged 10 years and above were used. For children older than 10 years, normal resting heart rate ranges from 60-100 beats per minute (National Institute of Health, 2009). Hence, after the 6-week intervention program, subjects had a lower resting heart rate mean score. Warburton et al. (2007) obtained a lower maximal heart rate during their interactive intervention program.

Research has found that overweight and obese children demonstrate poor flexibility and muscular endurance compared with their normal weight peers (Sung, 2005). The results in Table 2 indicate a high consensus towards poor flexibility; muscular endurance, however, expresses contradiction to the above study. Grund et al. (2000) revealed that muscular strength is not associated with body mass in young children. Deforche et al. (2003) concluded that obese children have greater muscular strength because they are used to carrying more weight. Flexibility decreased after the intervention program and then increased again in the final assessment. This may be explained by the increase in muscle that occurred during the intervention program with muscles becoming shorter and flexibility decreasing.

Results indicate an increase in muscular endurance from first to last assessment. Upper body muscular endurance (tested with the push-up test) increased progressively but not significantly ($p=0.26$) throughout the assessments. Interestingly, the PACER performance mean decreased after the intervention program and showed an increased mean value in the last assessment. The decreased motivation levels observed among subjects during the last assessment could explain the declining value. High temperature and humidity on the day of testing might also be considered as an external factor influencing performance. Furthermore, the structure of the testing may have exaggerated the results as the PACER test was conducted last.

Control group A and B results. Members of control group A ($n=10$) and control group B ($n=10$) were offered no rewards because of financial constraints. During the final assessment, 3

subjects in control group A and 2 in control group B withdrew from the study. This clearly influenced the results making them less broad-based. The post-post-test was conducted two weeks before the school holidays when the soccer world cup began, followed by the national school teachers' strike during which schools were closed for up to four-weeks. These might be additional reasons why participants withdrew from both control groups.

Control group A results. The subjects in control group A had access to traditional video games for a period of 6-weeks.

Table 4
Control Group A Mean Scores and Standard Deviation on Health-related Fitness

| CONTROL GROUP A | | | | | | |
|--|-------|-------|--------|-------|--------|-------|
| Health-related Fitness Protocols | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| BM | 71.2 | 20.02 | *72.35 | 20.45 | 53.3 | 41.24 |
| WHR | 0.88 | 0.05 | 0.77 | 0.27 | 0.6 | 0.42 |
| Fat % | 103.3 | 24.92 | 95.1 | 19.56 | 68.7 | 51.36 |
| SBP | 119.6 | 13.6 | 117.8 | 9.65 | 81.1 | 56.35 |
| DBP | 77.33 | 10.44 | 73.5 | 7.84 | 49 | 34.54 |
| RHR | 90.6 | 16.39 | 85.2 | 15.7 | 58.6 | 41.33 |
| M. Endurance | 12.7 | 8.29 | *18.8 | 10.61 | 17.6 | 16.26 |
| M. Strength L | 18.9 | 5.03 | *19.3 | 6.69 | 13.65 | 11.1 |
| M. Strength R | 18.05 | 8.13 | *18.9 | 7.49 | 12.7 | 10 |
| Flexibility | 29.7 | 7.62 | *33 | 9.6 | 20.8 | 15.65 |
| Cardiovascular Endurance | 2.76 | 1.23 | *2.9 | 0.86 | 1.89 | 1.33 |

* Indicates items that increased

Results in Table 4 reveal an increase in the mean body mass in the post-test. A large dip is then seen in the post-post-test partially influenced by the number of dropouts. Remarkably, the increased body mass in the post-test corresponds with a decrease in both waist-to-hip ratio and

fat percentage. This could again be because subjects were at the prepuberty stage when both height and growth spurts occur.

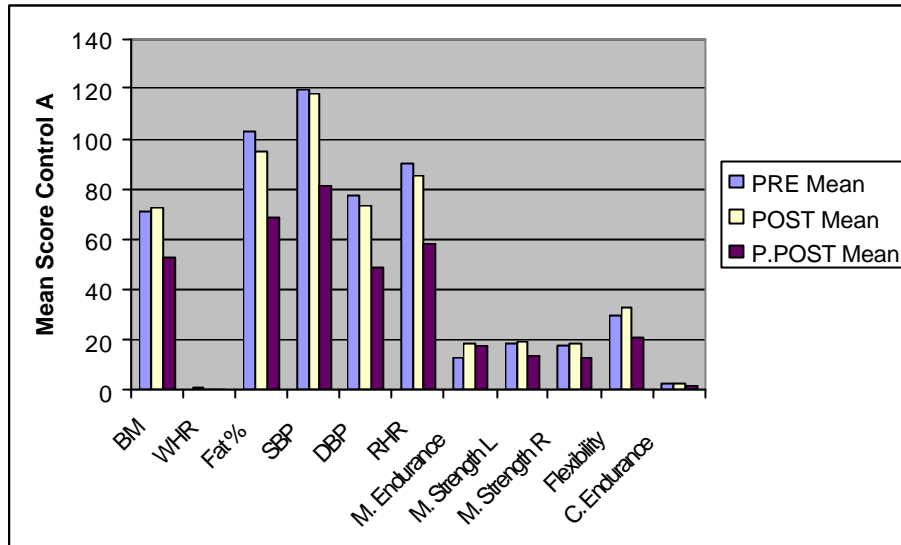


Figure 7. Control Group A Mean Scores on Health-related Fitness.

Prehypertension in both systolic and diastolic blood pressure is seen in the pre-test (see Figure 7). Prehypertension can be the result of a sedentary lifestyle. Blood pressure decreases in the *post-* and *post-post-*tests. Resting heart rate decreases in the *post-*test and again in the *post-post-*test. Increases are seen in upper body muscular endurance, muscular strength, flexibility and cardiovascular endurance in the *post-*test. This can be explained by body maturation.

Control group B results. Control group B's mean scores and standard deviation on health-related fitness can be seen in Table 5.

Table 5
Control Group B Mean Scores and Standard Deviation on Health-related Fitness

| CONTROL GROUP B | | | | | | |
|----------------------------------|-------|-------|--------|-------|--------|-------|
| Health-related Fitness Protocols | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| BM | 61.1 | 11.95 | *63.2 | 12.4 | 52.6 | 30.04 |
| WHR | 0.83 | 0.06 | 0.82 | 0.06 | 0.66 | 0.35 |
| Fat % | 97.2 | 24.43 | 90.5 | 16.1 | 72.3 | 40.46 |
| SBP | 118.3 | 7.73 | *120.7 | 5.33 | 94.3 | 50.15 |
| DBP | 69 | 5.68 | *77.6 | 15.45 | 55.4 | 30.01 |
| RHR | 90.8 | 15.09 | 81 | 12.34 | 67.3 | 39.42 |
| M. Endurance | 15.1 | 7.48 | *15.9 | 7.43 | 15 | 9.71 |
| M. Strength L | 15 | 3.51 | 14.55 | 3.8 | 12.5 | 7.25 |
| M. Strength R | 15.3 | 4.04 | 14.95 | 4.26 | 12.6 | 7.47 |
| Flexibility | 33.6 | 7.28 | 32.3 | 7.7 | 28.3 | 16.8 |
| Cardiovascular Endurance | 4.24 | 1.51 | 3.29 | 1.82 | 2.42 | 1.8 |

* Indicates items that increased

Both mass and fat percentage in the *post*-test demonstrate an increase in mean scores. Waist-to-hip ratio shows a slight decrease by 0.01 in the *post*-test. Decreased mean values in the *post-post*-test in weight, fat percentage and waist-to-hip ratio.

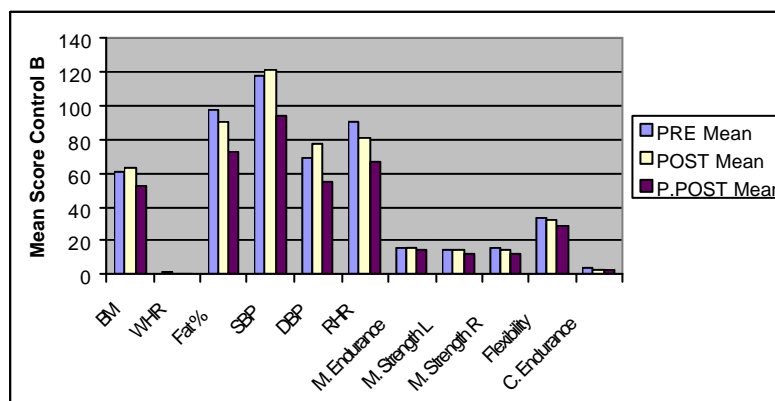


Figure 8. Control Group B Mean Scores on Health-related Fitness.

Prehypertension is seen in the pre-test of both systolic and diastolic blood pressure. Prehypertension is aggravated by an increase in blood pressure mean scores in the *post*-test. A large drop occurs in the *post-post*-test as a result of participants dropping out. Resting heart rate shows a progressive decrease throughout the assessments. Upper body strength increases to some extent in the *post*-test and decreases again in the *post-post*-test. Muscular strength demonstrates an odd decrease throughout assessments. Flexibility and cardiovascular endurance decrease in both the *post*- and *post-post*-test. This could indicate a decreased level of fitness.

Comparison of health-related fitness results. Figures 9, 10 and 11 illustrate the difference between the results of the research groups. There were no significant changes in health-related fitness parameters between the groups.

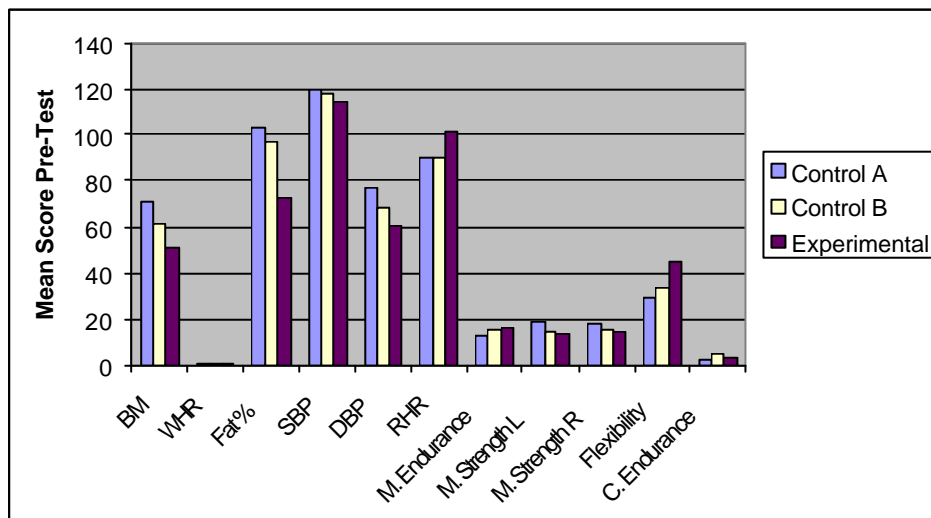


Figure 9. Group Comparison Mean Scores on Health-related Fitness in Pre-test.

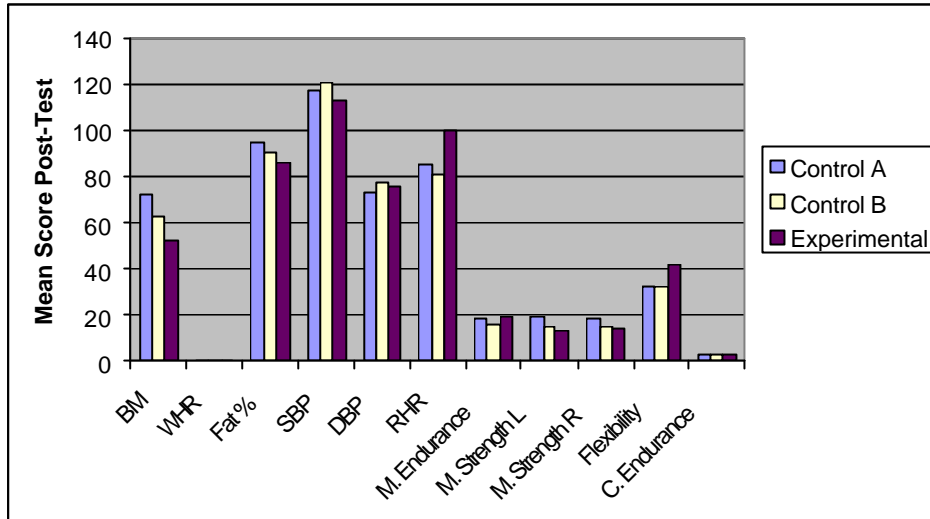


Figure 10. Group Comparison Mean Scores on Health-related Fitness in Post-test.

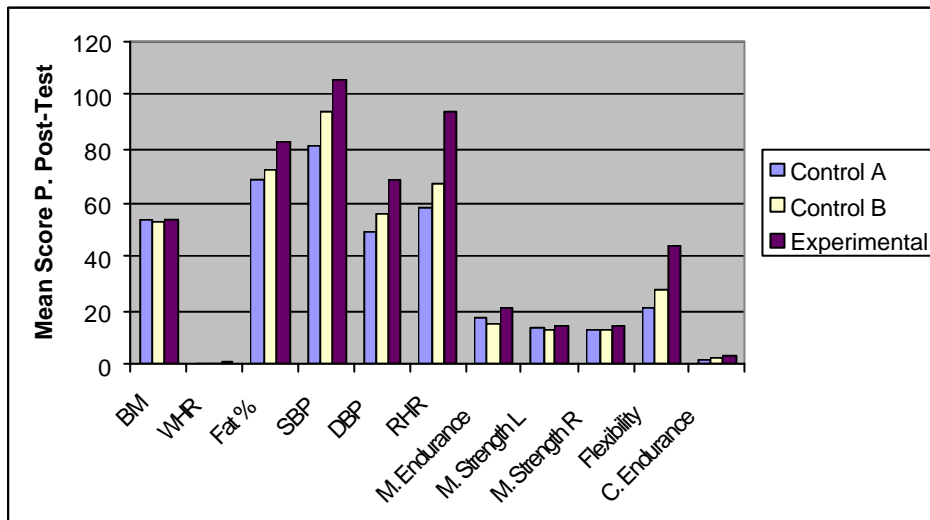


Figure 11. Group Comparison Mean Scores on Health-related Fitness in Post-post-test.

In comparing results between the research groups the following were noted:

- ✍ There was no significant change in body mass, waist-to-hip ratio or fat percentage in either of the groups. Body mass in control groups A and B was much higher than in the

experimental group throughout the study. The fact that the experimental group was situated in a rural area and control groups A and B in the city may explain the larger mass.

- ✍ The pre-test indicated that both the control groups started off with higher health-related fitness levels than the experimental group. However, of the two control groups only control group B and the experimental group did not have the same opportunities to improve fitness.
- ✍ Systolic blood pressure (SBP) increased in control group B in the *post*-test but showed a decreased value in the *post-post*-test. Both control group A and the experimental group demonstrate a progressive decrease in SBP in the *post*- as well as the *post-post*-test. Warburton et al. (2007) reported significant reductions in resting SBP after their 6-week interactive video game exercise intervention.
- ✍ Similar results were found in diastolic blood pressure (DBP) for control group B and the experimental group, which again showed an increase in mean value in the *post*-test (as with SBP). However, the mean scores of both these groups decreased in the *post-post*-test. As for control group A, there was a continued decrease throughout the assessments.
- ✍ Resting heart rate decreased continuously in all groups throughout the assessments.
- ✍ Upper body muscular endurance increased in the experimental group and shows a further increase in the *post-post*-test indicating that retention was obtained. Control groups A and B produced results parallel to each other, demonstrating improvement in the *post*-test but improved mean scores were not maintained in the *post-post*-test.
- ✍ The experimental group displayed a small decrease in muscular strength relating to the left side (LS) of the body. The subjects of this group improved their mean score in the *post-post*-test. The experimental group also showed an increased mean score in muscular strength relating to the right side (RS) of the body, as shown in Table 4. This might be because subjects in the experimental group had a mean dominant right side. This was noticed while subjects were playing games during the intervention program. LS and RS strength mean scores improved in control group A during the *post*-test and showed no retention value afterwards. Mean scores for control group B in both LS and RS strength declined overall.

✍ The results for flexibility and cardiovascular endurance reflect similar patterns for all groups. Control group A showed an increase in both mean scores although improvements were lost in the last assessment. Mean scores in control group B display performance regression. The experimental group shows small decreased mean scores during the *post*-test. However, mean scores improve during the *post-post*-test.

The above results indicate insignificant differences between the experimental group and control groups A and B with regard to health-related physical fitness. These findings indicate that exergaming does not meet the daily recommended energy expenditure of the American College of Sport Medicine (2006). This is supported by several other studies which concluded that exergaming cannot be used to replace physical activity but can increase and promote physical activity in children (Graves et al., 2008; Graves et al., 2007; Lanningham-Foster et al., 2009).

Functional Fitness Results

Functional fitness in this study involved agility, speed, balance, reaction time and coordination. The implementation of the results can be assumed from the aspect of a linear relationship between mean score and performance with the exception of speed and agility. The mean score of speed and agility represents the actual amount of time it took to complete the test, thus displaying an inverse relationship between mean score and performance. The descriptive statistics of the three groups are displayed in Table 6.

Table 6
Group Comparison Mean Scores and Standard Deviation on Functional Fitness

| | CONTROL A (Mean Age = 11.2) | | | CONTROL B (Mean Age = 11.5) | | | EXPERIMENTAL (Mean Age = 11.5) | | |
|-------------------|--------------------------------|-------|--------|--------------------------------|------|--------|-----------------------------------|-------|--------|
| | PRE | POST | P.POST | PRE | POST | P.POST | PRE | POST | P.POST |
| Speed and Agility | 7.1 | 7.4* | 4.5 | 7.9 | 9.4* | 5.3 | 8.36 | 6.27 | 6.09 |
| Balance | 4 | 3.8 | 2.7 | 3.8 | 3.7 | 3 | 3.82 | 4* | 4 |
| Reaction Time | 9.9 | 13.3* | 6.9 | 8.1 | 9.5* | 7.8 | 6.55 | 9.1* | 12.73 |
| Coordination | 4.4 | 5* | 3.33 | 4.8 | 4.9* | 3.9 | 3.73 | 4.82* | 4.73 |

Experimental group results. Results as in Table 7 indicate that the experimental group had significant differences in speed and agility, reaction time and coordination. The improvements were outstanding at 37%, 94% and 28% respectively. Balance, however, showed only a slight increase ($p=0.3$).

Table 7
Experimental Group Mean Scores and Standard Deviation on Functional Fitness

| EXPERIMENTAL GROUP | | | | | | |
|--------------------|------|------|-------|------|--------|------|
| | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| Speed and Agility | 8.36 | 1.63 | 6.27 | 1.56 | 6.09 | 1.51 |
| Balance | 3.82 | 0.6 | *4 | 0 | 4 | 0 |
| Reaction Time | 6.55 | 1.92 | *9.1 | 1.85 | *12.73 | 1.9 |
| Coordination | 3.73 | 1.01 | *4.82 | 0.4 | 4.73 | 0.65 |

* Indicates items that increased

Figure 12 shows that the greatest significant difference found was in reaction time. The fact that the Nintendo Wii functions from an observe-respond manner may contribute to this great improvement.

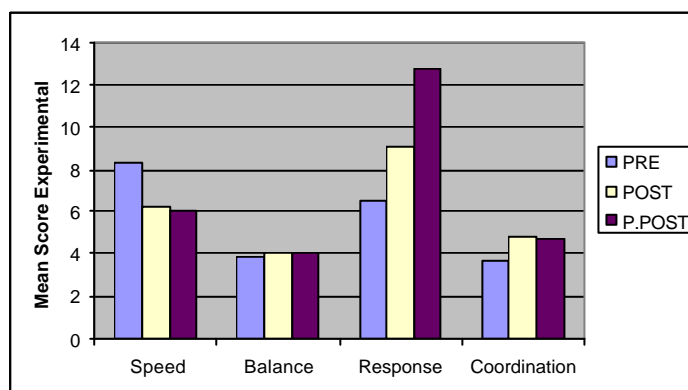


Figure 12. Experimental Group Mean Scores on Functional Fitness.

Functional fitness that was tested showed a definite improvement, with reaction time, speed and agility showing greatest improvement.

Control group A results. Table 8 indicates an increase in speed and agility which actually suggests deterioration in performance throughout the study. A similar pattern of deterioration is seen in balance. Reaction time and coordination improved insignificantly.

Table 8
Control Group A Mean Scores and Standard Deviation on Functional Fitness

| CONTROL GROUP A | | | | | | |
|-------------------|------|------|-------|------|--------|------|
| | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| Speed and Agility | 7.1 | 1.1 | *7.4 | 1.96 | 4.5 | 3.37 |
| Balance | 4 | 0 | 3.8 | 0.42 | 2.7 | 1.89 |
| Reaction Time | 9.9 | 1.91 | *13.3 | 2.87 | 6.9 | 6.44 |
| Coordination | 4.4 | 1.07 | *5 | 0 | 3.33 | 2.5 |

* Indicates items that increased

Figure 13 illustrates noticeable decreases in performance in the final assessment; this can be explained because a number of participants dropped out.

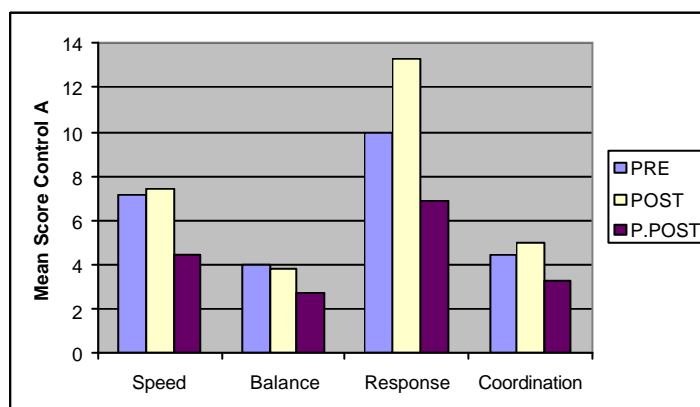


Figure 13. Control Group A Mean Scores on Functional Fitness.

Control group B results. Table 9 and Figure 14 display the functional fitness results for control group B. Performance in speed and agility along with balance declined throughout the

assessments, whereas, reaction time and coordination show small improvements as seen in Figure 14.

Table 9
Control Group B Mean Scores and Standard Deviation on Functional Fitness

| CONTROL GROUP B | | | | | | |
|-------------------|------|------|------|------|--------|------|
| | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| Speed and Agility | 7.9 | 1.85 | 9.4 | 1.65 | 5.3 | 3.3 |
| Balance | 3.8 | 0.63 | 3.7 | 0.67 | 3 | 1.7 |
| Reaction Time | 8.1 | 2.13 | 9.5 | 2.76 | 7.8 | 5.22 |
| Coordination | 4.8 | 0.42 | 4.9 | 0.32 | 3.9 | 2.08 |

* Indicates items that increase

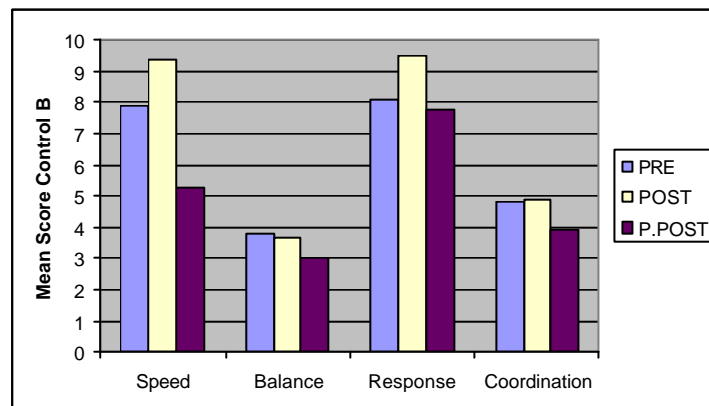


Figure 14. Control Group B Mean Scores on Functional Fitness.

The noticeable fall in performance seen in Figure 14 in the *post-post*-test can be attributed to participants dropping out.

Comparison of functional fitness results. After 6-weeks, the functional fitness of the subjects in the experimental group had improved more than that of the subjects in control groups A and B. However, all groups increased in coordination and reaction time. Motor development follows a predictable timeline, with motor abilities developing at certain ages (Pieterse, 2002).

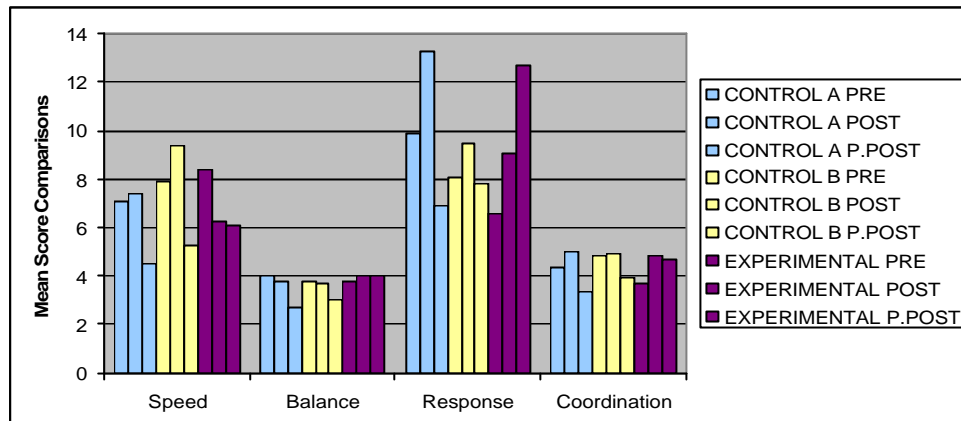


Figure 15. Group Comparison Mean Scores on Functional Fitness.

The results of control groups A and B did not show any significant changes and while speed, agility and balance did not improve in either control group and even showed some regression. The improved level of functional fitness in experimental and control groups may result from other factors than the intervention program.

Research has found that reaction speed increases with age (Anderson, Nettelbeck & Barlow, 1997). However, the experimental group shows a much larger improvement in reaction time which may be due to the intervention program. Research has reported that computer games can be used to improve coordination and reaction time (Lawrence, 1986).

Self-concept Results

The second research hypothesis states that exergaming will enhance self-concept amongst overweight and obese children. The Cratty Self-concept Questionnaire operates according to expected responses; the end score represents the number of expected responses out of 20 questions. In other words, the end score symbolizes a positive relationship with one's self-concept. The higher the score, the greater the self-concept. Table 10 demonstrates the results found in self-concept.

Table 10
Group Comparison Mean Scores and Standard Deviation on Self-concept

| Questionnaire Mean Score Comparison | | | | | | |
|-------------------------------------|-------|------|-------|------|--------|------|
| Research Groups | PRE | | POST | | P.POST | |
| | Mean | SD | Mean | SD | Mean | SD |
| Experimental (Mean Age = 11.5) | 12.36 | 4.97 | 9.09 | 4.93 | 12.55* | 4.91 |
| Control A (Mean Age = 11.2) | 9.8 | 5.61 | 10.4* | 6.1 | 8.6 | 7.49 |
| Control B (Mean Age = 11.5) | 10.4 | 6.79 | 12.2* | 5.85 | 11.2 | 7.96 |

*Indicates items that increased

Experimental group results. Results for self-concept in the experimental group are shown in Table 11 and graphically displayed in Figure 16.

Table 11
Experimental Group Mean Scores and Standard Deviation on Self-concept

| Experimental Group | | | | | |
|--------------------|------|------|------|--------|------|
| PRE | | POST | | P.POST | |
| Mean | SD | Mean | SD | Mean | SD |
| 12.36 | 4.97 | 9.09 | 4.93 | 12.55* | 4.91 |

* Indicates items that increased

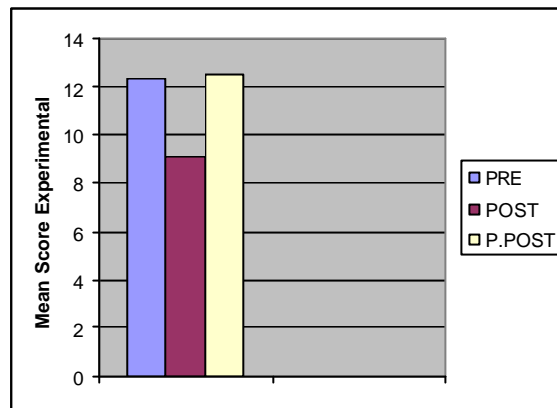


Figure 16. Experimental Group Mean Scores on Self-concept.

Results indicate a large fall in the mean score of the experimental group's second assessment, with an increase in the third assessment. The results can be explained by a number of factors. Firstly, a competitive situation can lead either to enthusiasm or fear of failure (Potgieter, 2003). The second assessment led to a competitive situation, with the intervention program coming to a sudden end which could have led subjects expect some external reward. Such expectations might have arisen from the researcher's continuous requests to attend intervention sessions to avoid more dropouts towards the end of the program. Secondly, self-efficacy is determined by positive past experiences, social persuasions and vicarious experiences. Positive past experiences refer to the amount of success experienced in the specific areas of dimension (cognitive, physical or social). Social persuasions refer to the opinions of an individual's peers, often referred to as the judgments made by others of the individual concerned. This also includes the individual's own judgments about himself or herself. Our tendency to model ourselves on significant others plays a major role in the way we are socialized and this is known as vicarious learning (Potgieter, 2003).

Lastly, self-esteem changes throughout development. It is influenced by the knowledge we have of ourselves. Self-knowledge varies in nature. This may explain the decrease in physical self-concept in overweight and obese children as they become more aware of their physical shape.

Control group A results. The self-concept mean score improved during *post* assessment but decreases are shown in the *post-post*-assessment as indicated in Table 12 and Figure 17.

Table 12
Control Group A Mean Scores and Standard Deviation on Self-concept

| Contrd Group A | | | | | |
|----------------|------|-------|-----|--------|------|
| PRE | | POST | | P.POST | |
| Mean | SD | Mean | SD | Mean | SD |
| 9.8 | 5.61 | *10.4 | 6.1 | 8.6 | 7.49 |

* Indicates items that increased

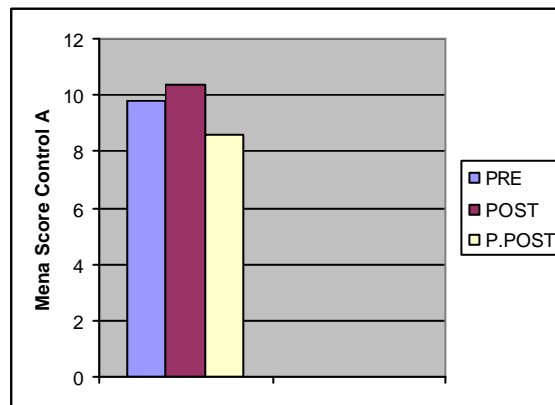


Figure 17. Control Group A Mean Scores on Self-concept.

Control group B results. Table 13 and Figure 18 indicate increased self-concept values after the baseline assessment, showing no retention of the increase in the last assessment.

Table 13
Control Group B Mean Scores and Standard Deviation on Self-concept

| Control Group B | | | | | |
|-----------------|------|-------|------|--------|------|
| PRE | | POST | | P.POST | |
| Mean | SD | Mean | SD | Mean | SD |
| 10.4 | 6.79 | *12.2 | 5.85 | 11.2 | 7.96 |

* Indicate items that increased

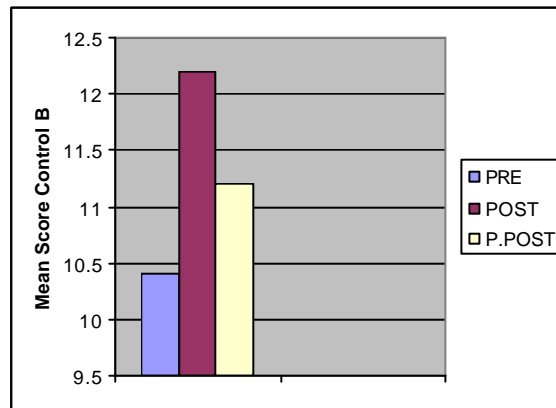


Figure 18. Control Group B Mean Scores on Self-concept.

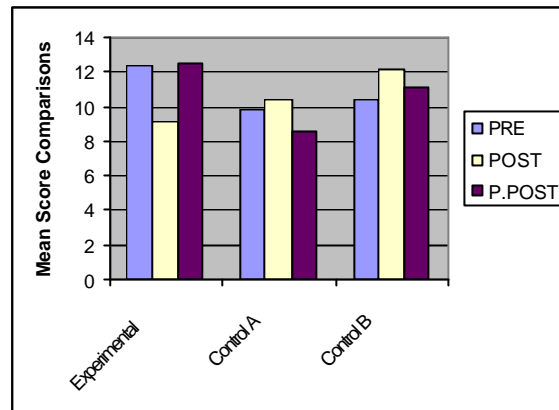


Figure 19. Group Comparisons Mean Scores on Self-concept.

Comparison of self-concept results. Figure 19 outlines differences between the research groups with regard to the variable, self-concept. Both control groups reflect a positive relationship between age and self-concept whereas the experimental group indicates a negative relationship. The experimental group shows greater self-concept in the baseline assessment compared to both control groups. Results for control groups A and B demonstrate similar patterns, an increase in the *post*-test and a decrease in the *post-post*-test. Interestingly, after the intervention program results for the experimental group show a large decrease which is then accompanied by an increase in *post-post*-assessment. Self-concept is influenced by a number of factors, with completing a questionnaire being influenced by the specific situation in which the individual finds himself or herself.

Ethnic or cultural differences should also be considered when analyzing self-concept. Research has shown that the “ideal physique” differs from culture to culture (Mvo, Dick & Steyn, 1999). For example, being fat can be an indication of wealth in certain cultures whereas in other cultures it is seen as unhealthy, unattractive and even unacceptable. Such variations can be used to explain baseline mean scores among the research groups since the experimental group consisted only of black subjects and both the control groups only of white subjects. In addition, the fact that body mass was much greater in both the control groups may have contributed to lower self-concepts.

Since the Nintendo Wii intervention program focused on physical activity (which plays a crucial role in healthy living) it might have stimulated the experimental group’s awareness of their physique. The decrease seen in the *post*-test in the experimental group may be the result of

this, with the increase of self-concept after the intervention program reflecting the removal of the intervention program.

Attitude towards Physical Activity Results

The third research hypothesis is that exergaming will have a positive effect on attitude towards physical activity among overweight and obese children. Attitude towards physical activity was not measured with a questionnaire as physical activity is an unknown concept and is not offered at the schools concerned. Instead an interview was conducted consisting of closed-ended questions after each session during the intervention program.

Experimental group results. Table 14 represents the interval results during the intervention program for the experimental group.

Table 14
Experimental Group Mean Scores and Standard Deviation on Attitude towards Physical Activity

| Intervention Program | | | | | |
|----------------------|------|-----------|------|-----------|------|
| 1-2 Weeks | | 3-4 Weeks | | 5-6 Weeks | |
| Mean | SD | Mean | SD | Mean | SD |
| 9.27 | 1.85 | 9.1 | 1.64 | *9.64 | 1.21 |

* Indicate items that increased

Results show that subjects felt more reassured and competent as the intervention program progressed in regard to the games that were played. Figure 20 illustrates the possible increased incentive value of success throughout the intervention program, which may be explained by subjects improving their techniques over the 6-week period. Similar results have been found in a study which concluded that subjects became more skillful throughout the Nintendo Wii intervention program and for this reason the level of enjoyment also increased (Pasch et al., 2009).

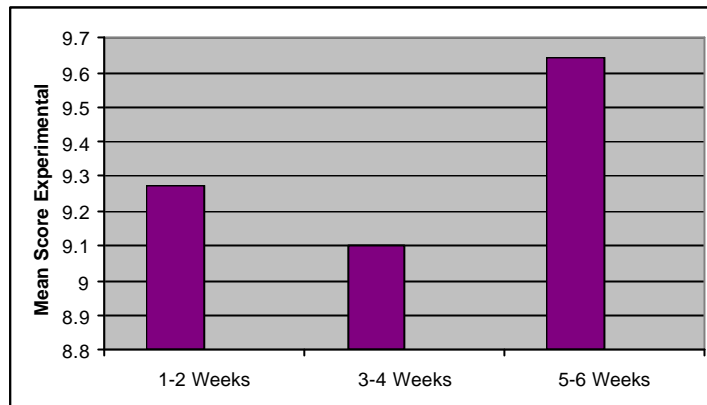


Figure 20. Experimental Group Mean Scores on Attitude towards Physical Activity.

Control group A and B results. Given that both schools in the control groups shared similar perceptions of after school physical activities, logbooks were not completed or returned.

Comparison of attitude towards physical activity results. Control group A had more exposure to physical activities during school hours. According to the competence motivation theory, exposure plays an important role in attitude towards physical activity. A child exposed to physical activity gains experience, which can be either positive or negative. The nature of the experience influences the perceived level of competence. In other words, positive experiences are associated with high levels of motivation concerning physical activity that might then lead to possible participation. Moreover, significant others play major roles in children’s lives. This places great emphasis on the need to educate society on the benefits of physical activity.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Conclusion

The goal of the current study was to investigate the hypothesis that a 6-week exergaming program can improve overweight and obese children's level of physical fitness and self-concept as well as their attitude towards physical activity. The following conclusions are drawn from the three programs conducted in the research:

Exergaming program. Participating in a 6-week exergaming program improved the level of functional fitness as well as positively influencing the attitude towards physical activity. No significant changes to health-related fitness and self-concept were found.

Traditional video gaming program. A 6-week traditional video gaming program had no significant impact on overall fitness level, attitude towards physical activity or self-concept of overweight and obese children.

No intervention program. There were no improvements in fitness, attitude towards physical activity and self-concept in obese children over a 6-week period of time.

These findings suggest that exergaming can provide greater improvements in functional fitness and attitude towards physical activity than a traditional video gaming program. This is of particular benefit considering the new generation's desire to be up-to-date with technology. Therefore, it is important to consider exergaming as a means to develop and improve functional fitness as well as improve the attitude towards physical activity among overweight and obese children. Most studies conducted in this area are concerned with the health-related components of physical fitness which often leads to the neglect of functional fitness. What is more important than the ability of the body to perform prolonged activities in everyday life? The results in this study significantly highlight the fact that an exergaming intervention program can improve levels of physical functioning. Furthermore, several studies have reported insignificant changes in

health-related fitness components after an exergaming intervention program. Researches propose utilizing exergaming as means to increase and promote daily physical activity rather than replace physical activity. This study supports the proposed concept given the obvious enjoyment among and involvement of subjects in the experimental group during the intervention program.

From this perspective, it is urged that exergaming should be incorporated into school based physical activity programs as well as movement development programs. This study confirms that a 6-week exergaming program improves functional fitness and attitude towards physical activity and thus has the potential to be used to increase and promote physical activity levels and development in children (Graves et al., 2008; Graves et al., 2007; Lanningham-Foster et al., 2009).

Recommendations

Based on the findings and conclusions of this study, the following recommendations can be used as guidelines to address child obesity at home, in schools and in communities:

1. This study integrates the physical, emotional and social facets of wellness emphasizing that lifestyle change should not be separated from daily life. Thus weight loss interventions should incorporate family, friends, religion, school and so fort. Exergaming is a convenient activity that can be easily integrated into everyday life.
2. Schools should increase participation in sport by making curriculum activities fun, attractive and relevant to physical activity requirements. Nintendo Wii sport is an excellent way to achieve these results. The use of exergaming in the educational context should be considered.
3. Parents should encourage physical activity during and after school hours and discourage sedentary screen time by replacing it with exergaming.
4. The school curriculum should provide sufficient knowledge on both health- and functional-related fitness benefits.
5. Representatives from the various education departments should ensure that teachers are appropriately qualified for their role as physical activity promoters and educators.

6. Finally, observations made during the intervention program call for critical nutritional guidance for both children and their parents. Communities should be educated on dietary practices.

Future Research

The significant findings of this study contribute to the research literature on child obesity as well as future development of ecological perspective exergaming based intervention. Further investigations should be conducted on the long-term effect of exergaming on functional physical fitness in overweight and obese children. The development of the exercise properties in exergaming is also required.

REFERENCES

- Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, New Jersey: Prentice-Hall.
- American Academy of Pediatrics. (2003). Prevention of pediatric overweight and obesity. *Pediatrics*, 112, 424-430.
- American Academy of Pediatrics. (2001). Committee on public education: Children, adolescents and television. *Pediatrics*, 107, 423-426.
- American College of Sports Medicine. (2006). *ACSM's guidelines for exercise testing and prescription* (7th ed.). Baltimore: Williams & Wilkins.
- Andersen, R.E., Crespo, C.J., Bartlett, S.J., Cheskin, L.J., & Pratt, M. (1998). Relationship of physical activity and television watching with body weight and level of fatness among children. Results from the national health and nutrition examination survey III. *The Journal of the American Medical Association*, 279, 938-942.
- Anderson, M., Nettelbeck, T., & Barlow, J. (1997). Reaction time measures of speed of processing: Speed of response selection increases with age but speed of stimulus categorization does not. *British Journal of Developmental Psychology*, 15, 145-157.
- Arenz, S., Ruckerl, R., Koletzko, B., & von Kries, R. (2004). Breast feeding and childhood obesity: A systematic review. *International Journal of Obesity and Related Metabolic Disorders*, 28(10), 1247-56.
- Armstrong, N., & Bray, S. (1991). Physical activity patterns defined by continuous heart rate monitoring. *Archives of Disease in Childhood*, 66, 245-247.

- Armstrong, J., & Reilly, J.J. (2002). Breastfeeding and lowering the risk of childhood obesity. *The Lancet*, 359(9322), 2003-2004.
- Attitude (psychology). (n.d.). In *Wikipedia: The free encyclopedia*. Retrieved August 1, 2009, from [http://en.wikipedia.org/wiki/Attitude_\(psychology\)](http://en.wikipedia.org/wiki/Attitude_(psychology))
- Baechle, T.R., & Earle, R.W. (1994). *Essentials of strength training and conditioning*. (2nd ed.). United States: National Strength and Conditioning Association.
- Bale, J. (1994). *Landscapes of modern sport*, Leicester University Press, Leicester, UK.
- Barlow, S.E., & Dietz, W.H. (1998). Obesity evaluation and treatment: expert committee recommendations. *Pediatrics*, 102, e29.
- Bar-Or, O., & Baranowski, T. (1994). Physical activity, adiposity, and obesity among adolescents. *Pediatric Exercise Science*, 6, 348-360.
- Beale, I., Kato, P., Marin-Bowling, V., Guthrie, N., & Cole, S. (2007). Improvement in cancer-related knowledge following use of a psycho-educational video game for adolescents and young adults with cancer, *Journal of Adolescent Health*, 41, 263–270.
- Becker, M.H., & Maiman, L.A. (1975). Sociobehavioral determinants of compliance with health care and medical care recommendations. *Medical Care*, 13, 10-24.
- Bekker, T., & Eggen, B. (2008). *Designing for children's physical play*. *Raising Children Network*. Association for Computing Machinery. Italy: Florence.
- Bianchi-Berthouze, N., Kim, W.W., & Darshak, P. (2007). Does body movement engage you more in digital game play? And why? *Springer*, 4738, 102-113.

- Biddle, S., & Goudas, M. (1996). Analysis of children's physical activity and its association with adult encouragement and social cognitive variables. *Journal of School Health, 66*(2), 75-78.
- Boreham, C., & Riddoch, C. (2001). The physical activity, fitness and health of children. *Journal of Sports Sciences, 19*, 915-929.
- Boreham, C., Twisk, J., Murray, L., Savage, M., Strain, J.J., & Cran, G. (2001). Fitness, fatness, and coronary heart disease risk in adolescents: the Northern Ireland Young Hearts Project. *Medicine and Science in Sports and Exercise, 33*, 270-274.
- Bouchard, C. (1991). Heredity and the path to overweight and obesity. *Medicine and Science in Sports and Exercise, 23*, 285-291.
- Bruininks, R.H. (1978). *Bruininks oseretsky test of motor proficiency manual*. Minnesota: American Guidance Service.
- Chamerlin, B., & Gallagher, R. (2008, May). *Exergames using video games to promote physical activity*. Paper presented at the Children, Youth and Families At Risk Conference, San Antonio, TX.
- Cocke, A. (2002). *Brain May Also Pump up from Workout*. Retrieved November 22, 2002, from <http://www.neurosurgery.medsch.ucla.edu/whastnew/societyforneuroscience.htm>
- Cole, T.J., Bellizzi, M.C., Flegal, K.M., & Dietz, W.H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal, 320*(7244), 1240-1243.

- Cooper, D.M., Poage, T.J., Barstow, T.J., & Springer, C. (1990). Are obese children truly unfit? Minimizing the confounding effect of body size on the exercise response. *Pediatrics*, 116, 223-230.
- Corbin, C.B., & Lindsey, R. (1997). *Concepts of Physical Fitness with Laboratories*. Brown & Benchmark Publishers.
- Daley, A.J. (2009). Can Exergaming contribute to improving physical activity levels and health outcomes in children? *Pediatrics*, 124,763-771.
- Dalleck, L.C., Bausch, I., Beran, J., Cahanes, S., & Krug, L. (2008). Physiological Responses While Playing Nintendo Wii Sports. *Official Research Journal of the Department of Kinesiology*, 3(2), 19-25.
- Daniels, S.R., Arnett, D.K., Eckel, R.H., Gidding, S.S., Hayman, L.L., Kumanyika, S., ...Williams, C.L. (2005). Overweight in children and adolescents: Pathophysiology, consequences, prevention, and treatment. *Circulation: Journal of the American Heart Association*, 111, 1999-2012.
- Dasgupta, C., Kim, H., Kogan, A., & Novitzky, M. (2007). *Battling childhood obesity P1: Understanding the problem*. The Visionaries.
- Davison, K.K., & Birch, L.L. (2001). Weight status, parent reaction, and self-concept in five-year-old girls. *Pediatrics*, 107(1), 46-53.
- Deater-Deckard, K. (2001). Annotation: Recent research examining the role of peer relationships in the development of psychopathology. *Journal of Child Psychology and Psychiatry*, 42, 565-579.

- Deforche, B.I., Lefevre, J., De Bourdeaudhuij, I.M., Hills, A.P., Duquet, W., & Bouckaert, J. (2003). Physical fitness and physical activity in obese and nonobese Flemish youth. *Obesity Research*, 11, 434-441.
- Deforche, B.I., De Bourdeaudhuij, I.M., & Tanghe, A.P. (2006). Attitude toward physical activity in normal weight, overweight and obese adolescents. *Journal of Adolescent Health*, 38, 560-568.
- Dewey, K.G. (2003). Is breastfeeding protective against child obesity? *Journal of Human Lactation*, 19(1), 9-18.
- D'Hondt, E., Deforche, B., De Bourdeaudhuij, I., & Lenoir, M. (2009). Relationship between motor skill and body mass index in 5- to 10-year-old children. *Adapted Physical Activity Quarterly*, 26(1), 21-37.
- DiLorenzo, T.M., Stucky-Ropp, R.C., Vander Wal, J.S., & Gotham, H.J. (1998). Determinants of exercise among children II. A longitudinal analysis. *Preventive Medicine*, 27, 470-7.
- Dodd, C.J. (2007). Energy regulation in young people. *Journal of Sport Science and Medicine*, 6, 327-336.
- Dorman, S. (1997). Video and computer games: Effect on children and implications for health education, *Journal of School Health*, 67(4), 133-138.
- Durnin, J.V.G.A. (1992). Physical activity levels past and present. In: *Physical activity and health*, Cambridge: Cambridge University Press, 20-27.
- Du Toit, D., & Pienaar, A.E. (2003). Overweight and obesity and motor proficiency of three- and four-year old children. *South African Journal for Research in Sport, Physical Education and Recreation*, 25(2), 37-48.

- Eisenberg, M.E., Neumark-Sztainer, D., & Story, M. (2003). Associations of weight-based teasing and emotional well-being among adolescents. *Archives of Pediatrics and Adolescent Medicine*, 157(8), 733-738.
- Eliamkim, A., Kaven, G., Berger, I., Friedland, O., Wolach, B., & Nemet, D. (2002). The effect of a combined intervention on body mass index and fitness in obese children and adolescents a clinical experience. *European journal of pediatrics*, 161(8), 449-452.
- Exergaming. (n.d.). In *Wikipedia: The free encyclopedia*. Retrieved June 2, 2009, from <http://en.wikipedia.org/wiki/Exergaming>
- Faith, M.S., Berman, N., Heo, M., Pietrobelli, A., Gallagher, D., Epstein, L.H.,... Allison, D.B. (2001). Effects of contingent television on physical activity and television viewing in obese children. *Pediatrics*, 107, 1043-1048.
- Fisher, A., Reily, J.J., Kelly, L.A., Montgomery, C., Williamson, A., Paton, J.Y., & Grant, S. (2005). Fundamental movement skills and habitual physical activity in young children. *Medicine & Science in Sports & Exercise*, 37, 684-688.
- Fitzgibbon, M.L., Blackman, L.R., & Avellone, M.E. (2000). The relationship between body image discrepancy and body mass index across ethnic groups. *Obesity Research*, 8(8), 582-589.
- Focht, B.C., & Hausenblas, H.A. (2004). Perceived evaluative threat and state anxiety during exercise in women with social physique anxiety. *Journal of Applied Sport Psychology*, 16, 361-368.
- Fox, K.R. (1999). The influence of physical activity on mental well being. *Public Health Nutrition*, 2(3a), 411-418.

- Fox, K.R., & Corbin, C.B. (1989). The Physical self-perception profile: Development and preliminary validation. *Journal of Sport & Exercise Physiology*, 11, 408-430.
- Franken, R. (1994). *Human motivation* (3rd ed.). Pacific Grove, CA: Brooks & Cole Publishing.
- Franklin, J., Denyer, G., Steinbeck, K.S., Caterson, I.D., & Hill, A.J. (2006). Obesity and risk of low self-esteem: a state-wide survey of Australian children. *Pediatrics*, 118(6), 2481-2487.
- Gaskins RB., LaGasse L.L, Liu J., Shankaran S., Lester B.M., Bada H.S., ...Roberts, M. (2010). Small for gestational age and higher birth weight predict childhood obesity in preterm infants. *American Journal of Perinatology*, 9, 721-730.
- Geng, G.H. (2009, October). *Comparison of involvement between traditional and technology assisted physical activities of five year olds*. Paper presented at the TE Learn Conference, Academia Sinica: Taipei, Taiwan.
- Gillman, M.W., Rifas-Shiman, S.L., Camargo, C.A., Berkey, C.S., Frazier, A.L., Rockett, H.R.H.,... Colditz, G.A. (2001). Risk of overweight among adolescents who were breastfed as infants. *The Journal of the American Medical Association*, 285, 2461-2467.
- Goedecke, J.H., Jennings, C.L., & Lambert, E.V. (Ed.). (2006). *Obesity in South Africa*. In chronic diseases of lifestyle in Africa 1995-2005. Cape Town: South Africa Medical Research Council.
- Goldfield, G.S., Kalakanis, L.E., Ernst, M.M., & Epstein, L.H. (2000). Open-loop feedback to increase physical activity in obese children. *International Journal of Obesity and Related Metabolic Disorders*, 24, 888-892.

- Graf, D.L., Pratt, V.L.V., Hester, C.N., & Short, K.R. (2009). Playing active video games increases energy expenditure in children. *Pediatrics*, 124, 534-540.
- Graves, L., Ridgers, N., & Stratton, G. (2008). 'The contribution of upper limb and total body movement to adolescents' energy expenditure whilst playing Nintendo Wii'. *European Journal of Applied Physiology*, 104(4), 617-623.
- Graves, L., Stratton, G., Ridgers, N.D., & Cable, N.T. (2007). Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: Cross sectional study. *British Medical Journal*, 335(7633), 1282-1284.
- Green, J., Waters, E., Haikerwal, A., O'Neill, C., Raman, S., Booth, M.L., & Gibbons, K. (2003). Social, cultural and environmental influences on child activity and eating in Australian migrant communities. *Child: Care, Health and Development*, 29(6), 441-448.
- Grund, A., Dilba, B., Forberger, K., Krause, H., Siewers, M., Rieckert, H., & Muller, M.J. (2000). Relationships between physical activity, physical fitness, muscle strength and nutritional state in 5- to 11-year-old children. *European Journal of Applied Physiology*, 82, 425-438.
- Hardy, L.R., Harrell, J.S., & Bell, R.A. (2004). Overweight in children: Definition, measurements, confounding factors, and health consequences. *Journal of Pediatric Nursing*, 19(6), 376-384.
- Hastad, D.N., & Lacy, A.C. (1998) *Measurement and Evaluation in Physical Education and Exercise Science*. (3rd ed.). Gorsuch Scarisbrick Publishers.
- Haywood, K.M., & Getchell, N. (2005). *Life span motor development* (4th ed.). Champaign, IL: Human Kinetics.

Health benefits of gaming. (2008). Retrieved August 2, 2009, from <http://vgevo.com/site/index.php>

Heyward, V.H. (2002). *Advanced fitness assessment and exercise prescription* (4th ed.). Human Kinetics.

Hughes, A.R., McLaughlin, R., McKay, J., & Mutrie, N. (2007). The B'Active Programme for overweight primary school children in Glasgow: Determining the prevalence of overweight and obesity and piloting an activity intervention. *British Journal of Nutrition*, 97, 204-209.

Huitt, W. (2009). *Self-concept and self-esteem*. Educational psychology interactive. Valdosta, GA: Valdosta State University. Retrieved from <http://www.edpsycinteractive.org/topics/regsys/self.html>

James, W. (1890). *The principles of psychology*. New York: Dover.

Jirage, R. (2008). *Childhood obesity facts*. Retrieved July 21, 2009, from <http://www.buzzle.com/articles/childhood-obesity-facts.html>

Kamtsios, S., & Digelidis N. (2007). Physical fitness, nutritional habits and daily locomotive action of 12 years children with different body mass index. *Inquiries in Sport & Physical Education*, 5(1), 63-71.

Kim, J., Must, A., Fitzmaurice, G.M., Gillman M.W., Chomitz, V., Kramer, E., McGowan, R., & Peterson, K.E. (2005). Relationship of physical fitness to prevalence and incidence of overweight among schoolchildren. *Obesity Research*, 13, 1246-1254.

- Kim, S.Y.S., Barton, B.A., Berhane, K., Ross, J.W., Payne, G.H., & Schreiber, G.B. (1997). Self-esteem and adiposity in black and white girls: The NHLBI growth and health study. *Annals of Epidemiology*, 7(3), 550-560.
- Lanningham-Foster, L., Foster, R.C., McCrady, S.K., Jensen, T.B., Mitre, N., & Levine, J.A. (2009). Activity-promoting video games and increased energy expenditure. *Pediatrics*, 154(6), 819-823.
- Lanningham-Foster, L., Jensen, T.B., Foster, R.C., Redmond, A. B., Walker, B.A., Heniz, D., & Levine, J.A. (2006). Energy expenditure of sedentary screen time compared with active screen time for children. *Pediatrics*, 118, 1831-1835.
- Latner, J.D., & Stunkard, A.J. (2003). Getting worse: The stigmatization of obese children. *Obesity Research*, 11(3), 452-456.
- Lau, P.W.C., Cheung, M.W.L., & Ransdell, L.B. (2008). A structural equation model of the relationship between body perception and self-esteem: Global physical self-concept as the mediator. *Psychology of Sport and Exercise*, 9, 493-509.
- Laurson, K.R., Eisenmann, J.C., Welk, G.J., Wickel, E.E, Gentile, D.A., & Walsh, D.A. (2008). Combined influence of physical activity and screen time. Recommendation on childhood overweight. *Pediatrics*, 153, 209-214.
- Lawrence, G.H. (1986). Using computers for the treatment of psychological problems. *Computers in Human Behavior*, 2, 43-62.
- Levine, J.A. (2007). Measurement of energy expenditure. *Public Health Nutrition*, 8(7A), 1123-1132.
- Lieberman, D. (2001). Management of chronic pediatric diseases with interactive health games:

- Theory and research findings, *Journal of Ambulatory Care Management*, 24(1), 26–38.
- Lobstein, T.J., Baur, L., & Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obesity Reviews*, 5(1), 4S–85S.
- Lohman, T.G., Roche, A.F. & Marforell, E.R. (1988). *Anthropometric standardization reference manual*. Human Kinetics.
- Longhurst, G.K. (1995). *The effects of participation in an educational sport programme on the motor proficiency of children with physical disabilities* (Unpublished master's thesis). Department of Sport Science, University of Stellenbosch, Stellenbosch, South Africa.
- Madsen, K.A., Yen, S., Wlasiuk, L., Newman, T.B., & Lustig, R. (2007). Feasibility of a dance videogame to promote weight loss among overweight children and adolescents. *Archives of Pediatrics and Adolescents Medicine*, 161(1), 105-107.
- Malina, R. (1999). Normal weight gain in growing children. *Healthy Weight Journal*, 13, 37-38.
- Malina, R.M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity*. (2nd ed.). Human Kinetics.
- Marsh, H.W. (2002). A multidimensional physical self concept: A construct validity approach to theory, measurement, and research. *Psychology: The Journal of the Gellenic Psychological Society*, 9, 459-493.
- Marsh, H.W., & Peart, N. (1988). Competitive and cooperative physical fitness training programs for girls: Effects on physical fitness and on multidimensional self concepts. *Journal of Sport and Exercise Psychology*, 10, 390-407.

- Martinez-Vizcaino, V., & Sanchez-Lopez, M. (2008). Relationship between physical activity and physical fitness in children and adolescents. *Revista Espanola de Cardiologia*, *61*(2), 108-111.
- Mattocks, C., Ness, A., Deere, K., Tilling, K., Leary, S., Blair, S.N., & Riddoch, C. (2008). Early life determinants of physical activity in 11 to 12 years olds: cohort study. *British Medical Journal*, *336*, 26-29.
- McArdle, W.D., Katch, F.I., & Katch, V.L. (2007). *Exercise physiology, energy, nutrition and human performance* (6th ed.). London: Lippincott Williams & Wilkins.
- Mellecker, R.R., & McManus, A.M. (2008). Energy expenditure and cardiovascular responses to seated and active gaming in children. *Archives of Pediatrics & Adolescent Medicine*, *162*(9), 886-891.
- Mhurchu, C.N., Maddison, R., Jiang, Y., Jull, A., Prapavessis, H., & Rodgers, A. (2008). Couch potatoes to jumping beans: A pilot study of the effect of active video games on physical activity in children. *The International Journal of Behavioral Nutrition and Physical Activity*, *5*, 8. doi:10.1186/1479-5868-5-8.
- Molnar, D., & Livingstone, B. (2000). Physical activity in relation to overweight and obesity in children and adolescents. *European journal of pediatrics*, *159*, S45-SS55.
- Moore, L.L., Di Gao, A.S., Bradlee, M.L., Cupples, L.A., Sundarajan-Ramamurti, M.A., Proctor, M.D., ...Ellison, R.C. (2003). Does early physical activity predict body fat change throughout childhood? *Preventive Medicine*, *37*(1), 10-17.
- Mota, J., Flores, L., Ribeiro, J.C., & Santos, M.P. (2006). Relationship of single measures of cardiorespiratory fitness and obesity in young schoolchildren. *American Journal of Human Biology*, *18*, 335-341.

- Mvo, Z., Dick, J., & Steyn, K. (1999). Perceptions of overweight African women about acceptable body size of women and children. *Curationis*; 22, 27-31.
- Nader, P.R., Bradley, R.H., Houts, R.M., McRitchie, S.L., & O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *The Journal of the American Medical Association*, 300(3), 295-305.
- National Institute of Health. (2009). *Blood pressure section of the physician examination*. Retrieved October 24, 2010, from http://www.cdc.gov/nchs/about/major/nhanes/NHANES99_00.htm
- Nippold, M., Duthie, J., & Larson, J. (2005). Literacy as a leisure activity: Free time preferences of older children and young adolescents. *Language, Speech and Hearing Services in Schools*, 36(2), 93-102.
- Nowicka, P., & Flodmark, C.E. (2007). Physical activity – key issues in treatment of childhood obesity. *Acta Paediatrica*, 96, 39-45.
- Obesity. (n.d.). In *Wikipedia: The free encyclopedia*. Retrieved August 12, 2010, from <http://en.wikipedia.org/wiki/Obesity>
- Odum, E.P. (1971). *Fundamentals of Ecology* (3rd ed.). Saunders, Philadelphia.
- O'Loughlin, J., Gray-Donald, K., Paradis, G., & Meshefedjian, G., (2000). One- and two-year predictors of excess weight gain among elementary schoolchildren in multiethnic, low-income, inner-city neighbourhoods. *The American Journal of Epidemiology*, 152, 739–746.

- Ong, K.K., & Dunger, D.B. (2002). Perinatal growth failure: road to obesity, insulin resistance and cardiovascular disease in adults. *Best Practice and Research Clinical Endocrinology and Metabolism*, 16, 191-207.
- Ortega, F.B., Ruiz, J.R., Hurtig-Wennlof, A., & Sjostrom, M. (2008). Los adolescentes fisicamente activos presentan mas probabilidad de una capacidad cardiovascular saludable independientemente del grado de adiposidad. The European youth heart study. *Revista Espanola de Cardiologia*, 61, 123-129.
- Ogden C., & Carrol M. (2010). *Prevalence of obesity among children and adolescents*. Division of health and nutrition examination surveys. Retrieved June 6, 2010, from www.cdc.gov/obesity/childhood/prevalence.html
- Parizkova, J., & Hills, A. (2001). *Childhood obesity: Prevention and treatment*. Chemical Rubber Company Press.
- Pasch, M., Bianchi-Berthouze, N., van Dijk, E.M.A.G., & Nijholt, A. (2009). *Movement-based sports video games: Investigating motivation and gaming experience*. *Entertainment Computing*, 1(2), 49-61.
- Paw, M., Jacobs, W. M., Vaessen, E. P. G., Titze, S., & van Mechelen, W. (2008). The motivation of children to play an active video game. *Journal of Science and Medicine in Sport*, 11(2), 163-166.
- Pettitt, D.J., Wollitzer, A.O., & Jovanovic, L. (2005). Interactive video games as an alternative exercise option for obese adolescents. *Diabetologia*, 48, A72.
- Pieterse, M. (2002). *School readiness through play*. Hoheizen: Metz Press.

- Potgieter, J.R. (2003). *Sport Psychology: Theory and Practice*. Stellenbosch: Institute of Sport Science Stellenbosch University.
- Powell, V., (2008). *Exertion interfaces: A flexible approach*. Paper presented at the association for computer machinery computer human interaction, Exertion interfaces workshop.
- Pratchett, R. (2005). *Gamers in the UK; Digital play, digital lifestyles*. BBC White paper.
- Psarra, G., Nassis, G.P., & Sidossis, L.S.(2005). Overweight and obesity: Short-term predictors of abdominal obesity in children. *European Journal of Public Health, 16*(5), 520-525.
- Puoane, T., Steyn, K., Bradshaw, D., Laubsher, R., Fourie, J., Lambert, V. & Mbananga, N. (2002). Obesity in South Africa: The South African demographic and health survey. *Obese Research, 10*, 1038-1048.
- Rhodes, R.E., Courneya, K.S., & Jones, L.W. (2004). Personality and social cognitive influences on exercise behaviour: adding the activity trait to the theory of planned behaviour. *Psychology Sport Exercise, 5*, 243-254.
- Ricciardelli, L.A., & McCabe, M.P., (2001). Children's body image concerns and eating disturbance: a review of the literature. *Clinical Psychological Review, 21*(3), 325-344.
- Rice, M. H., & Howell, C. C. (2000). Measurement of physical activity, exercise, and physical fitness in children: Issues and concerns. *Journal of Pediatric Nursing, 15*, 148-156
- Ridley, K., & Olds, T. (2001). Video center games: energy cost and children's behaviors. *Pediatric Exercise Science, 13*, 413-421.

- Robertson, N., & Vohora, R. (2008). Fitness vs. fatness: Implicit bias towards obesity among fitness professionals and regular exercisers. *Psychology of Sport and Exercise*, 9, 547-557.
- Rosenbaum, M., & Leibel, R.L. (1998). The physiology of body weight regulation: relevance to the etiology of obesity in children. *Pediatrics*, 101, 525-539.
- Rowland, T. (1990). *Exercise and children's health. obesity and physical activity.* Human Kinetics.
- Rowlands, A.V., Eston, R.G., & Ingeledew, D.K. (1999). Relationship between activity levels, aerobic fitness, and body fat in eight- to ten-year old children *Journal of Applied Physiology*, 86(4), 1428-1435.
- Santos, V., & Sawaia, B. (2000). A bolsa na mediação estar ostomizado – estar profissional: análise de uma estratégia pedagógica. *Revista Lation-Americana De Enfermagem*, 8, 40-50.
- Scheuer, L.J., & Mitchell, D. (2003). *Does physical activity influence academic performance?* Retrieved October 12, 2009, from <http://www.sportsmedia.org/sportsapolisnewsletter19.htm>
- Schwartz, M.B., Chambliss, H.O., Brownell, K.D., Blair, S.N., & Billington, C. (2003). Weight bias among health professionals specializing in obesity. *Obese Research*, 11, 1033-1039.
- Segal, K.R., & Dietz, W.H. (1991). Physiologic responses to playing a video game. *American Journal of Diseases of Children*, 145, 1034-1036.
- Self concept. (n.d.). In *Wikipedia: The free encyclopedia*. Retrieved August 1, 2009, from http://en.wikipedia.org/wiki/Self_concept

- Shah, A. (2010). *Obesity*. Global issues: Social, political, economic and environmental issues that affect us all. Retrieved July 22, 2010, from <http://www.globalissues.org/article/558/obesity>
- Sherrill, C. (2004). *Adapted physical activity, recreation, and sport: Cross disciplinary and lifespan*. (5th ed.). New York: McGraw-Hill.
- Singh, G.K., Kogan, M.D., van Dyck, P.C., & Siahpush, M. (2008). Racial/Ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: Analyzing Independent and joint associations. *Annals of Epidemiology*, 9(18), 682-695.
- Slade, P.D. (1994). What is body image? *Behavior Research and Therapy*, 32, 497-502.
- Sobal, J., & Stunkard, A.J. (1989). Socioeconomic status and obesity: a review of the literature. *Psychological Bulletin*, 105, 260-275.
- Steinbeck, K.S. (2001). The importance of physical activity in the prevention of overweight and obesity in childhood: a review and an opinion. *Obesity Reviews*, 2, 117-130.
- Stettler, N., Zembel, B.S., Kumanyika, S., & Stallings, V.A. (2002). Infant weight gain and childhood overweight status in a multicenter, cohort study. *Pediatrics*, 109, 194-199.
- Stokols, D. (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion*, 10(4), 282-298.
- Strauss, R.S. (2000). Childhood obesity and self esteem. *Pediatrics*, 105, 105-110.

- Strauss, R.S., & Knight, J. (1999). The influence of home environment on the development of obesity in children. *Pediatrics*, 6, 103.
- Strazzulo, P., Cappuccio, F.P., Trevisan, M., De Leo, A., Krogh, V., Giorgione, N., & Mancini M. (1988). Leisure time physical activity and blood pressure in school children. *The American Journal of Epidemiology*, 127, 726-733.
- Strong, W.B., Malina, R.M., Blimkie, C.J., Daniels, S.R., Dishman, R.K., Gutin, B., ...Trudeau, F. (2005). Evidence based physical activity for schoolage youth. *Pediatrics*, 146(6), 732-737.
- Stucky-Ropp, R., & DiLorenzo, T. (1993). Determinants of exercise in children. *Preventive Medicine*, 22, 880-889.
- Summerbell, C.D., Waters, E., Edmunds, L., Kelly, S.A.M., Brown, T., & Campbell, K.J. (2005). Interventions for preventing obesity in children. *Cochrane Database of Systematic Reviews*, 3, CD001871.
- Sung, R.Y.T. (2005). Self-perception of physical competences in preadolescent overweight Chinese children. *European Journal of Clinical Nutrition*, 59, 101–106.
- Sweeting, H.N. (2008) Gendered dimensions of obesity in childhood and adolescence. *Nutrition Journal*, 7, 1-14.
- Swinburn, B., Figger, G., Raza, F. (1999). Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine*, 29, 563–570.
- Tones, K., & Tilford, S. (2001). *Health promotion: effectiveness, efficiency and equity*. London: Nelson Thornes.

- US Department of Health and Human Services. (2007). *Overweight in children and adolescents*. Retrieved May 19, 2009, from http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_adolescents.htm
- Valdez, R., Athens, M.A., Thompson, G.H., Bradshaw, B.S., & Stern, M.P. (1994). Birthweight and adult health outcomes in a biethnic population in the USA. *Diabetologia*, 37, 624-631.
- Van Den Berg, B.P., Wertheim, E.H., Thompson, J.K., & Paxton, S.J. (2002). Development of body image, eating disturbance, and general psychological functioning in adolescent females: a replication using covariance structure modeling in an Australian sample. *International Journal of Eating Disorders*, 32(1), 46-51.
- Vandewater, E.A., Shim, M., & Caplovitz, A.G. (2004). Linking obesity and activity level with children's television and video game use. *Journal of Adolescence*, 27, 71-85.
- Wabitsch, M. (2000). Overweight and obesity in European children: definition and diagnostic procedures, risk factors and consequences for later health outcome. *European Journal of Pediatrics*, 159, S8-S13.
- Wadden, T.A., & Stunkard, A.J. (2002). *Handbook of obesity treatment*. New York: The Guilford Press.
- Wang, X., & Perry, A.C. (2006). Metabolic and physiologic responses to video game play in seven to eight year old boys. *Archives of Pediatrics & adolescent medicine*, 160, 411-415.

- Warburton, D.E.R., Bredin, S.S.D., Horita, L.T.L., Zbogar, D., Scott, F.M., Esch, B.T.A., & Rhodes, R.E. (2007). The health benefits of interactive video game exercise. *Applied Physiology, Nutrition, and Metabolism*, 32, 655-663.
- Wardle, J., & Cooke, L. (2005). The impact of obesity on psychological well-being. *Best Practice & Research Clinical Endocrinology & Metabolism*, 19(3), 421-440.
- Willems, M.E.T., & Bond, T.S. (2009). Metabolic equivalent of brisk walking and playing new generation active computer games in young adults. *Medicina Sportiva*, 13(2), 1734-2260.
- Winnick, J.P., & Short, F.X. (1985). *Physical fitness testing of the disabled*. Human Kinetics.
- World Health Organization. (2003). *Obesity and overweight*. Retrieved September 18, 2008, from <http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/>
- Yawn, P., Algatt-Bergstrom, R., Yawn, P., Wollan, M., Greco, M., & Gleason, M. (2000). An in-school CD-rom asthma education programme. *Journal of School Health*, 70(4), 153-159.
- Young-Hyman, D., Tanofsky-Kraff, M., Yanovski, S.Z., Keil, M., Cohen, M.L., Peyrot, M., & Yanovski, J.A. (2006) Psychological status and weight-related distress in overweight or at-risk-for-overweight children. *Obesity*, 14(12), 2249-2258.
- Zabinski, M.F., Saelens, B.E., Stein, R.I., Hayden-Wade, H.A., & Wilfley, D.E. (2003). Overweight children's barriers to and support for physical activity. *Obese Research*, 11, 238-246.
- Zeller, M.H., Reiter-Purtill, J., & Ramey, C. (2008). Negative peer perceptions of obese children in the classroom environment. *Silver Spring*, 16(4), 755-762.

APPENDIX A
EXPLANATORY LETTER OF STUDY

UNIVERSITY OF ZULULAND

DEPARTMENT
OF
HUMAN MOVEMENT SCIENCE



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Dear Parents

Research study: Child obesity

The University of Zululand is currently conducting a research study. The topic documents the influence of exergaming on the fitness, attitude towards physical activity and self-concept in obese children.

The World Health Organization claims that the conditions of being overweight and obese are global epidemics, with more than 1 billion people classified as being overweight or obese. Twenty million of the 1 billion are overweight and obese children. The aim of this study is to answer the question as to whether and how the power of electronic games can drive children towards adopting a healthier lifestyle, becoming more physically active for life and improving their self-concept.

The study will consist of three groups: The experimental group (Nintendo Wii group), control group A (Traditional video game group) and control group B (No intervention group). The Nintendo Wii will be used by the experimental group in the study. Control group A will take part in traditional video games (playstation, television games). Control group B will continue with their everyday activities without any intervention. Control group A will participate in traditional video games in the comfort of their own home. The research study will proceed for a duration of 6-weeks and require participants to record their activities.

Please complete the consent form and return it immediately to the school to allow your child to participate in this study. You are welcome to contact me for further information.

Yours sincerely

Anneke van Biljon

APPENDIX B
CONSENT FORM AND CHILD ASSENT FORM

1. Anneke van Biljon, who is a Masters student at the University of Zululand, has requested my minor child's participation in a research study at this institution. The title of the research is *The influence of exergaming on the fitness; attitude towards physical activity and self-concept in obese children*.
2. I have been informed that the purpose of the research is to develop overall fitness, positively contribute to the attitude towards physical activity and increase the self-concept of obese children.
3. My child's participation will involve a Nintendo Wii program related to the Body Mass Index, Waist-to-hip ratio, Skinfold Measurements, PACER Test, Sphygmomanometer, Push up Test, Dynamometer, Sit-and-Reach Test, Bruininks Oseretsky Test Running Speed and Agility Subtest, Stork Stand Test, Ball Catch, Bruininks Oseretsky Test Reaction Speed Subtest, The Cratty Self-concept Scale. The program has a duration of 6-weeks and a frequency of 5 days per week. The sessions constitute 30 min per day.
4. There are no foreseeable risks or discomforts.
5. There are no feasible alternative procedures available for this study.
6. I understand that the possible benefits of my child's participation in the research are developing overall fitness; improve attitudes towards physical activity and improving self-concept, especially if my child is obese.
7. I understand that the results of the research study may be published but that my child's name or identity will not be revealed. In order to maintain confidentiality of my child's records, Anneke van Biljon will make use of codes representing each participant.
8. I have been advised that the research in which my child will be participating does not involve more than minimal risk.
9. I have been informed that I will not be compensated for my child's participation.
10. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Anneke van Biljon, 0827044583 or her supervisor, Dr G.K. Longhurst.

11. I understand that in case of injury, if I have questions about my rights as a participant in this research, or if I feel I have been placed at risk, I can contact the Chair of the Human Subject Research Review Committee.
12. I have read the above information. The nature, demands, risks and benefits of the project have been explained to me. I knowingly assume the risks involved and understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to me.

Subject's signature _____

Parent's signature _____

Date _____

13. I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, answered any questions that have been raised and witnessed the above signatures.
14. These elements of informed consent conform to the Assurance given by the University of Zululand to the Department of Health and Human Services to protect the rights of human subjects.
15. I have provided the subject with a copy of this signed consent document.

Signature of investigator _____

Date _____

CHILD ASSENT FORM

I, _____, understand that my parents have given permission for me to take part in a project about Nintendo Wii conducted by Anneke van Biljon.

I am taking part because I want to and I have been told that I can stop at any time I want to and that I won't get into trouble.

APPENDIX C

HEALTH-RELATED FITNESS



Health-related Protocols

The individual score sheet of the health-related protocols is later seen in this appendix . Measurements of stature, body mass and skinfolds were done according to the standard procedures suggested by the International Society for the Advancement of Kinanthropometry (ISAK).

Body Composition

Body composition refers to the degree of leanness/fatness of the individual. Although body composition is a factor in physical performance, it is also an indicator of the health of the individual. Typically, body composition is estimated by recording measures of height and weight and consulting tables to determine the appropriate weight for a particular height. Although easy to use, such tables have limitations because they do not take into account the build of the body and proportion of bone, muscle and fat. In assessment, it is possible for two individuals to have the same height and weight but differ in leanness/fatness. Thus, it is considered helpful to determine measures of body fat and use these in the assessment of body composition.

Stature

Stature is a major indicator of general body size and bone length. It is an important variable in screening for disease or malnutrition and in the interpretation of body mass (Lohman,

Roche & Marforell, 1988). Stature was measured with a calibrated height gauge. Stature was recorded in centimetres to the nearest millimetre with required accuracy of <2 mm, using a stadiometer. The subject stands erect and barefoot, with weight evenly distributed on both feet and the head in the Frankfurt Horizontal Plane. The arms must hang freely at the sides of the trunk with the palms facing the thighs. The heels must be placed together. Gluteus, scapulae and posterior cranium should be in contact with the stadiometer. Before taking the measurement the subject is instructed to inhale deeply and stretch upward to the fullest extent. The vertical distance from the vertex in the mid-sagittal plane to the floor is measured.

Body Mass

Body mass was measured in kilograms on a calibrated scale and recorded to the nearest 100 grams, with a required accuracy of <0.5 kg with the child clothed in his or her physical education clothes and taking care that:

The scale read zero;

The child was standing on the centre of the scale without support;

The child's weight was distributed evenly on both feet; and

The child's head was held up with eyes looking directly ahead.

Skinfolds

Ideally, body fat is determined by hydrostatic weighing. However, the necessary equipment is not readily available to individuals in field-based situations. Skinfold measurements were therefore used to estimate body fatness. Skinfold measurements have reasonable validity when correlated with hydrostatic weighing procedures. The use of skinfolds are also substantiated by the fact that approximately 50% of the body's total fat lies directly underneath the skin. The skinfold measurements are presented in percentile tables and can serve as a guide for determining leanness/fatness; however, these readings must be carefully interpreted (Winnick & Short, 1985)

The following measurement technique was applied for all site measurements, using a skinfold calliper exerting a uniform pressure of 10 g per 2 mm irrespective of the calliper opening. All measurements were taken on the dominant subject's side. The thumb and index

finger of the left hand were used to elevate a double fold of skin and subcutaneous adipose tissue 1 cm proximal to the site at which the skinfold was to be measured. Calliper jaws were applied at right angles to the site, approximately midway between the general surface of the body near the site and crest of the skinfold and the handles were fully released. Once full pressure was applied and initial needle drift had stopped, or a maximum period of 4 s had passed, the measurement was taken. Two measurements were taken and recorded to the nearest 0,5 mm. If the difference was greater than 1 mm, then a third measurement was taken and the mean of the two closest recorded. The skinfold sites were carefully located using the anatomical landmarks below.

Triceps Skinfold

The triceps skinfold was measured in the midline of the posterior aspect of the arm, over the triceps muscle, at a point midway between the lateral projection of the acromion process of the scapula and the inferior margin of the olecranon process of the ulna. The skinfold was measured with the arm hanging pendant and comfortably at the subject's side.

Sub- scapular Skinfold

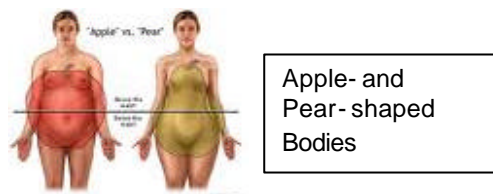
The sub-scapular skinfold was taken at a site approximately 2 cm below the tip of the scapula (inferior angle) and 2 cm toward the midline of the body. The measurement was taken on the child's dominant side. Research indicates that height, weight and muscle-fat ratio influence how children perform motor skills. Thus, all the above measurements were taken to determine how the child's body size affected his or her motor performance.

Waist-to-hip Ratio

Scientific evidence suggests that the way people store fat affects the risk for disease. Individuals with more fat on the trunk, especially abdominal fat, are at increased risk of hypertension, type II diabetes, hyperlipidemia, coronary artery disease and premature death (Corbin & Lindsey, 1997).

A waist-to-hip ratio test was designed to assess body composition. Waist-to-hip ratio looks at the proportion of fat stored on the body around the waist and hip. Most people store

body fat in two distinct ways: around the middle and around the hips. Typically (though not always), excess fat in women tends to collect in the hips and buttocks, resulting in the so-called "pear" shape. In men, excess fat often tends to collect in the abdomen area, resulting in what is called an "apple" shape.



The measurements were taken around the waist at the point of smallest circumference. The hip measurement was taken at the point of greatest circumference. The waist measurement was then divided into the hip measurement.

Cardiovascular Endurance

Cardiovascular endurance is described as the ability to perform dynamic exercise involving large muscle groups at moderate-to-high intensity for prolonged periods (American College of Sports Medicine, 2006). Cardiovascular fitness was assessed by means of the 20 m Progressive Aerobic Cardiovascular Endurance Run (PACER) test. The equipment for the test includes a measuring tape and a 20 m PACER Test audio CD.

The following procedure was adhered throughout: basic warm-up was done followed by stretching exercises in preparation for the test. The audio CD was then started. At the beginning, two bleeps indicate an accurately timed 1 min interval. This is to ensure that the tape's speed is correct. The CD then continues with a verbal explanation of the tape itself, leading to a 4 s countdown to the start of the test. The tape thereafter emits a single bleep at regular intervals. The subject aims to be at the opposite end of the start by the time the first bleep sound. The subject continues to run at this speed, being at one end or the other each time the bleep is emitted. After each minute, the time interval between the bleeps decreases making it necessary for the subject to increase his/her running speed. The first running speed is 8.5 km/h and is referred to as 'Level 1'. The next stage is referred to as 'Level 2' and each new level are characterized by a 0.5 km/h increase in running speed. Each level lasts approximately 1 min and the tape continues up to level 23. The end of each shuttle is denoted by a single bleep and a triple

bleep with a formal statement by the commentator on the tape denotes the end of each level.

Subjects were advised that the running speed at the start of the test is very slow and that they should pace themselves accordingly. Subjects had 9 s in which to complete each 20 m shuttle of level 1. Subjects were required to place 1 foot either on or behind the 20 m mark at the end of each shuttle. The subjects were further instructed that when they arrived a fraction earlier than the bleep, they had to wait for the bleep before they could resume running and adjust the running speed accordingly.

Each subject was encouraged to run as long as possible until he/she could no longer keep up with the speed set by the tape, at which point the subject was withdrawn from the test. Each subject had his/her own recorder whose task was to tick off each shuttle level completed by the subject and then record the level and the number of shuttles finally completed when the subject withdrew.

Heart Rate

Heart rate is recognized as an indicator of bodily effort or stress involved in the performance of physical work (Armstrong & Bray, 1991). Heart rate was recorded by using the telemetric Polar Heartwatch, a portable heart rate monitor. This has three components namely, the watch receiver, an electrode strap which is placed around the subject's chest at the level of the inferior border of the pectoralis muscle and the 'watch' which is attached to the subject's wrist.

Muscular Endurance

Muscular endurance is described as the ability of muscles to repeatedly exert themselves (Corbin & Lindsey, 1997). For the purpose of this study, the push-up test was used to test muscular endurance. The American College of Sports Medicine (2006) recommends the push-up to be done as follows: the subject assumes a standard push-up position, with thumbs shoulder width apart. Keeping the back and body straight, subjects descend to the testers fist, placed below the sternum and ascend until elbows are fully extended (straightened). This was done for 1 min. The number of repetitions performed in 1 min was recorded as a score. If the subject did not adhere to these specifications, the repetition was not counted.

Muscular Strength

Muscular strength is defined as the ability of a muscle group to develop maximal force against a resistance in a single contraction (Heyward, 2002). Static strength was assessed by the hand grip test. The handgrip test was performed with the handgrip dynamometer. The subject stood erect, with the arm and forearm positioned as follows: the subject kept the arm of the dominant hand straight and slightly abducted. The subject squeezed the dynamometer as hard as possible using one brief maximal effort but without any extraneous body movement. Three trials were done allowing 1 min rest between trials. The subject's best score was then used as the score.

Blood Pressure

Resting blood pressure was measured indirectly by using a sphygmomanometer consisting of a blood pressure cuff and mercury column manometer used for children. The subject's arm rested on a table so that the middle of the arm was at the level of the heart. The bladder of the cuff encircled 100% of the subject's arm. The examiner measured the subject's arm circumference at the midpoint of the arm. A deflated cuff was wrapped around the brachial artery pulse after palpating the pulse. The lower edge of the cuff was approximately 2.5 cm above the antecubital fossa. The blood pressure valve was closed following 70 mmHg inflation on the cuff with slow 10 mmHg increments of increased pressure while palpating the radial pulse. The systolic blood pressure was estimated as the pulse disappeared. The examiner opened the blood pressure valve by slowly releasing the pressure at a rate of 2-3 mmHg/sec estimating the diastolic blood pressure as the pulse reappears. Blood pressure values were recorded to the nearest 2 mmHg. Two trials were conducted with a 30 s rest in between tests.

Flexibility

The sit and reach apparatus is a box with a grid designed to measure one's reached length. The grid ranges from zero to 40 cm with the 23 cm line at the edge of the box. The apparatus was placed against a wall. The subject was instructed to remove shoes with feet flat against the side of the box. Legs were extended and hands placed on the box on top of each other. The subject then slowly reached as far forward as possible four times. On the fourth time the subject had to be able to hold the

reach for 1 s. A partner was required to hold the subject's legs throughout the test ensuring the legs were straight. A warm-up trial with two test trials were allowed using the average of the two test trials as the criterion score.

HEALTH-RELATED FITNESS INDIVIDUAL SCORE SHEET

| | | | | |
|--------------|--|--|--|--|
| 1. BM | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
|--------------|--|--|--|--|

| | | | | |
|--|--|--|--|--|
| 2. FAT % Triceps Sub-scap Calf | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
| | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
| | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
| | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |

| | | | | |
|---------------|--|--|--|--|
| 3. BMI | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
|---------------|--|--|--|--|

| | | | | |
|---------------|--|--|--|--|
| 4. RHR | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
|---------------|--|--|--|--|

| | | | | |
|-------------------------|----|----|----|----|
| 5. GRIP STRENGTH | L: | L: | L: | L: |
| | R: | R: | R: | R: |

| | | | | |
|-------------------------|----|----|----|----|
| 6. SIT AND REACH | 1: | 1: | 1: | 1: |
| | 2: | 2: | 2: | 2: |

| | | | | |
|---------------|----|----|----|----|
| 7. WHR | W: | W: | W: | W: |
| | H: | H: | H: | H: |

| | | | | |
|--------------|----|----|----|----|
| 8. BP | S: | S: | S: | S: |
| | D: | D: | D: | D: |

| | | | | |
|-------------------|--|--|--|--|
| 9. PUSH UP | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> | <input style="width: 90%;" type="text"/> |
|-------------------|--|--|--|--|

APPENDIX D FUNCTIONAL FITNESS

Functional Fitness Protocols

The individual score sheet on the functional fitness protocols can be found later in this appendix. All protocols were adapted from Bruininks Oseretsky test of motor proficiency manual (Bruininks, 1978).

Running Speed and Agility

The apparatus included masking tape, tape measure, block and stopwatch. The start and finish lines were marked with a 91.4 cm piece of masking tape on the floor. The timing line was marked with a 15.2 cm piece of masking tape measured from the centre of the starting line. The distance between the timing lines to the end line was 13.7 m. A small block was placed on the end line. The subject ran as fast as possible to the end line, picked up the block and ran back toward the finish line. The subject was timed at the crossing of the timing line. Two trials were allowed.

Balance: Standing on Preferred Leg

A target was placed on the wall at the subject's eye level. The subject stood 3 m away from the target. The subject then stood on the preferred leg and lifted the other leg parallel to the floor. Hands should be placed on the subject's hips. Two trial tests were recorded if the subject did not reach 10 s, the maximum score, in the first trial.

Coordination: Catching a Tossed Ball with Preferred Hand

The subject stood on a standing mat with the recorder 3 m away from the subject. The recorder threw the tennis ball underhand in a slight arc so that it came down between the subject's shoulders and waist. The subject aimed to catch the ball with both hands. One practice and five recorded trials were conducted.

Reaction Time

A 30.5 cm tape strip was placed on the wall just below the subject's shoulders. The subject and examiner were seated next to each other facing the wall. The examiner held the stick vertically against

the wall with the starting line on the masking tape and then dropped the stick. The subject was required to place his/her thumb on the starting line with the rest of the fingers placed flat on the wall in an attempt to stop the stick. The subject was given two practices and seven trials which were recorded.

FUNCTIONAL RELATED FITNESS INDIVIDUAL SCORE SHEET

Running Speed and Agility Trial 1 _____

Trial 2 _____

| | | | | | | | | | | | | | | | | |
|-------------|------------|-----------|-----------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|
| Raw Score | Above 11.0 | 10.9-11.0 | 10.5-10.8 | 9.9-10.4 | 9.5-9.8 | 8.9-9.4 | 8.5-8.8 | 7.9-8.4 | 7.5-7.8 | 6.9-7.4 | 6.7-6.8 | 6.3-6.6 | 6.1-6.2 | 5.7-6.0 | 5.5-5.6 | Below 5.5 |
| Point Score | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |

Standing on Preferred Leg on Floor (10 sec maximum per trial)

Trial 1 _____

Trial 2 _____

| | | | | | |
|-------------|---|-----|-----|-----|------|
| Raw Score | 0 | 1-3 | 4-5 | 6-8 | 9-10 |
| Point Score | 0 | 1 | 2 | 3 | 4 |

Reaction Time (2 Prac)

| Trial | Raw Score | Seconds |
|-------|-----------|---------|
| 1 | | 2 |
| 2 | | 3 |
| 3 | | 1 |
| 4 | | 3 |
| 5 | | 2 |
| 6 | | 1 |
| 7 | | 1 |

Catching a Tossed Ball with Preferred Hand (1 Prac)

| Trial | Raw Score |
|-------|-----------|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

APPENDIX E

CRATTY SELF-CONCEPT SCALE

The Cratty Self-concept Scale measures the dimensions of self-concept that applies to feelings about the self, specifically in movement contexts. It consists of 20 questions, each of which is answered with either “yes” or “no” thus, making it easy to administer to children. It is a screening instrument recommended for identifying children with low self-concept as movers (Longhurst, 1995).

Scoring. Do not print the scoring key on any questionnaires given to the children. Score 1 point for each response expected. Deduct 1 point for each positive expected answer which was circled **NO** and each negative expected answer which was circled **YES**. The score is the number of expected responses given for the 20 items.

Objective. To estimate how children feel about their physical appearance and their ability to perform physical skills and to identify children with low self-concept so that they can be helped.

Gender and Age. Boys and girls ages 5-12.

Reliability. Test reliability of .82 for 288 children.

Validity. Content validity with all items. Construct validity by method of known groups with every item discriminating between students with high and low scores on the total test.

Test description. A test of 20 brief questions to which the student responds with either “yes” or “no”.

Test directions. “You have a questionnaire that will determine how you feel about yourself. Each question will be read and you should then immediately decide how you feel and circle yes or no to the answer. The first question is _____. Now, circle “Yes” or “No”. (The question is repeated and the instruction to circle yes or no given again). The second question is _____ (Continue through the 20 items).

CRATTY SELF-CONCEPT SCALE

| Scoring | Question | Yes? | No? |
|---------|---|------|-----|
| > | 1. Are you good at making things with your hands? | yes | no |
| > | 2. Can you draw well? | yes | no |
| > | 3. Are you strong? | yes | no |
| > | 4. Do like the way you look? | yes | no |
| | 5. Do your friends make fun of you? | yes | no |
| > | 6. Are you handsome/pretty? | yes | no |
| | 7. Do you have trouble making friends? | yes | no |
| > | 8. Do you like school? | yes | no |
| | 9. Do you wish you were different? | yes | no |
| | 10. Are you sad most of the time? | yes | no |
| | 11. Are you the last to be chosen in games? | yes | no |
| > | 12. Do girls like you? | yes | no |
| > | 13. Are you a good leader in games and sports? | yes | no |
| | 14. Are you clumsy? | yes | no |
| | 15. In games, do you watch instead of play? | yes | no |
| > | 16. Do boys like you? | yes | no |
| > | 17. Are you happy most of the time? | yes | no |
| > | 18. Do you have nice hair? | yes | no |
| | 19. Do you play with younger children a lot? | yes | no |
| > | 20. Is reading easy for you? | yes | no |

APPENDIX F
CLOSED-ENDED QUESTIONS

Date _____

What sport did you play? _____

Were the games easy to play? _____

Did you have fun? _____

Total time _____

Comments

Supervisor

**APPENDIX G
INDIVIDUAL LOGBOOK**

Name & Surname

Age _____
Date of Birth _____
BMI _____
Weight _____
Height _____