PREVALENCE, INTERVENTION AND MANAGEMENT OF OVERWEIGHT AND OBESITY AMONG PRIMARY SCHOOL CHILDREN IN NAIROBI PROVINCE, KENYA.

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University

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This work is dedicated to my children Liz Njoki and Emmanuel Kamau as upcoming scholars.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAP---------------------------------- American Academy of Pediatrics

AFA…………………………………Arm fat area

BMI ---------------------------------- Body mass index

BIA----------------------------------- Bioelectric impendence Analysis

DHHSCDCP--------------------------Department of health and human services Centers for disease control and prevention

DW-------------------------------------Density of water

DXA----------------------------------- Dual-X-ray absorptiometry

KG------------------------------------- kilograms

mA -------------------------------------mili Ampere

MONICA------------------------------ Monitoring of trends and determinants in Cardiovascular diseases

PALS---------------------------------- Physical activity levels

RMR----------------------------------- Resting metabolic rate

SPSS---------------------------------- Statistical package for social scientists

WHO---------------------------------- World health organization

ABSTRACT

The prevalence of childhood overweight and obesity is increasing at an alarming rate worldwide and has implications for a variety of diseases. This has been due to various causes such as poor nutrition, inactivity or both. The purpose of this study was therefore to establish the prevalence of overweight and obesity among primary school children aged 10-15 years in Nairobi province, Kenya. The study also pursued establishing the efficacy of aerobic dance exercises as an intervention measure for managing overweight and obesity amongst children. It was also the purpose of the study to establish the congruence amongst BMI, BIA and skin fold methods in estimating overweight and obesity amongst children in Nairobi province. The study was carried out in two phases. A cross-sectional design was used in the first phase to assess the prevalence of overweight and obesity using BMI. The subjects in this phase included 2620 males and 2705 females aged 10 to 15 years in both private and public schools. A classic experimental design which involved an experimental group (48 pupils) and a control group (21 pupils) was then used for the second phase of the study which involved further assessment of overweight and obesity using BIA and skin fold measures. Data were analysed using percentiles, Correlations, paired samples t-tests, independent samples t-tests and one way analysis of variance at .05 level of significance. Post hoc tests using Tukey HSD were applied to locate inter-group differences upon significant F ratios. The results indicated that out of the 1479 pupils in private schools (103) 6.9% were obese while (245) 16.7% were overweight. On the other hand out of the 3846 pupils in public schools (62) 1.6% were obese while (220) 5.7% were overweight. Out of the total pool of 2620 male subjects, 170 (6.5%) of the male pupils were overweight while 67 (2.6%) of them were obese. The results also showed that out of the total 2760 female pupils, 295 (10.9%) of them were overweight while 98(3.6%) were obese. These results showed that overweight and obesity are prevalent among primary school children aged 10-15 years in Nairobi, Kenya. The results also indicated strong Pearson product moment correlations among BMI, BIA and skin fold which ranged from $r=0.57$ to $r=0.75$. The results further showed significant differences in body composition between boys and girls ($p>.05$) with female pupils being more susceptible to overweight and obesity as indicated by higher mean BMI scores compared to their male counterparts. It was also evident from the results that there were significant decreases ($p>0.5$) in mean BMI and mean percent body fat determined using BIA and skin fold calipers following involvement in the 10 weeks aerobic dance exercise programme. The study therefore recommended enhancement of regular physical activities amongst children using school-based programmes. It was also recommended inclusion of aerobic dance exercises in the existing primary school physical education curriculum. The study further suggested that similar assessments need to be carried out amongst children below 10 years in Kenya.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Obesity refers to an excess of body fat that frequently results in significant impairment of health. This in turn is dependent on the lipid content of each fat cell and on the total number of fat cells (Myers, 2004 and Foss and Keteyian, 1998). Obesity is apparent when fat accumulation produces a body weight that is more than 20 percent above an ideal or desirable weight (Payne and Hahn 2002 and Bessesen and Kushner, 2002). Foss and Keteyian (1998), indicate that, adipocytes (fat cells) increase in number (hyperplasia) through early adolescence as well as increase in size (hypertrophy). Obesity therefore is a combination of the number of fat cells (adipocytes) and their lipid content. Overweight on the other hand is apparent when the body weight is between one percent and nineteen percent above the desirable weight (Payne and Hahn, 2002). In children, overweight and obesity are present when their body weight meets or exceeds the 85^{th} percentile of the body mass index (Payne and Hahn 2002, WHO, 1998 and Bessesen and Kushner, 2002). This is to mean that in most cases overweight may lead to obesity. However this is not necessarily the case since an individual could be overweight due to accumulation of lean tissue other than the fat tissues.

Overweight and obesity in children and adolescents are generally caused by lack of physical activity, unhealthy eating patterns, or a combination of the two, with genetic and life –style both playing important roles in determining a child's weight (Payne and Hahn, 2002).

According to Tennefors and Forsum (2004), it is not possible to measure body fat content in a simple way. In addition, Howley and Franks (1997) indicate that the most accurate methods of determining body fat are by chemical analysis of human cadavers. However, these authors note that this is of no use to the health fitness instructor. As such, several direct methods that are widely used by exercise specialists have been validated by the information obtained from these direct measurements. Another direct technique that has traditionally been referred to as the "gold standard" is the underwater weighing (Howley and Franks, 1997). According to Goss, Robertson, Williams, Sward, Abt, Ladewig et al. (2003), this technique typically requires multiple trials, complete body immersion and the measurement of residual volume. However, Goss et al. (2003) note that this approach is time consuming, requires sophisticated instrumentation, is difficult to administer and is contraindicated to certain clinical sub-groups and children.

Given the limitations of the above body fat assessment procedures, various indexes for identifying overweight and obesity in humans have been developed, the most commonly used being body mass index (BMI) (Tennefors and Forsum, 2004). Although BMI is simple to measure, it is limited by the fact that it identifies subjects with an excessive body weight rather than subjects with an excessive amount of body fat (World Health Organization [WHO], 1998, Department of Health and Human Services Centers for Disease Control and Prevention [DHHSCDCP], 2007). This is to mean that BMI does not distinguish between weight associated with muscle and weight associated with fat.

Another simple and potentially useful method of estimating total body fat is the skin fold technique. This technique measures the thickness of the subcutaneous fat layer directly (Howley and Franks, 1997). According to Tennofers and Forsum (2004), skin fold measures are relatively easy to obtain but the pinching of calipers involve some discomfort for the child. Furthermore, the International Society for Advancement of Kinanthropometry (ISAK, 2001) indicates that some subjects may feel uncomfortable stripping down in front of the tester. This has somehow limited the wide spread application of skin fold assessment as a field based tool and has lead to the development of alternative techniques for estimating overweight and obesity.

One such technique is bioelectric impedance analysis (BIA). According to Goss et al. (2003), this procedure takes very little time, is easy to administer, requires no specialized training or practice for the investigator and is non-invasive. However, Goss et al. 2003 further indicate that bioelectric impedance derived body composition may be affected by hydration status, ambient temperature and recent exercise. Unfortunately, tight control over these potentially confounding variables may not be possible in field based or school environments. Therefore, there was need for a study that will examine the congruence of BIA with BMI and skin fold methods in estimating overweight and obesity with a view of establishing the reliability of using BIA in Kenyan children population.

Overweight and Obesity have become health hazards of epidemic proportions in most developed and developing countries of the world (Plourde 2006, Dietz, 1998). Foss and Keteyian (1998) and Colon et al. (2003) refer to overweight and obesity as major health problems for both adults and children because they have implications for a variety of diseases. Adami, Persson and Weider (2000) note that, obesity by itself has been associated with several serious health problems and accounts for 15-20 percent of annual mortality rate in the United States. It has been recognized as one of the major risk factors of cardiovascular diseases including coronary heart disease, hypertension, congestive heart failure, elevated blood cholesterol, respiratory difficulties and musculo-skeletal problems among others. Ponder and Anderson (2007) also note that childhood obesity is the greatest challenge to child health in the 21st century.

The prevalence of childhood overweight and obesity is increasing at an alarming rate in developed and developing countries of the world (American Academy of Pediatrics [AAP] 2007). For instance, Ponder and Anderson (2007) indicate that in 2006, the prevalence of obesity in children reached 17 percent in the United States. These authors further warn that, if current trends remain unchanged, the prevalence of childhood obesity is expected to reach 20 percent by 2010.

Childhood obesity is not only confined to industrialized countries, as high rates are already evident in some developing countries (Stettler, Bovet, Shamlaye, Zemel, Stallings and Paccaud 2002, WHO, 1998). For instance, WHO (1998) indicates that the prevalence of obesity among school children aged 6-12 years in Thailand, as diagnosed by weight for height greater than 120 percent of the Bangkok reference, rose from 12.2 percent in 1991 to 15.6 percent in 1993. Additionally a study of 6-18 year-old male school children in Saudi Arabia showed that the prevalence of obesity was 15.8 percent in 1993.

In Africa, research has shown an increasing prevalence of childhood overweight and obesity. For instance, Armstrong, Lambert, Sharwood and Lambert (2006) conducted a study in South Africa to determine the prevalence of obesity and overweight among primary school children. These authors found that the prevalence of obesity within the sample was 3.2 percent for boys and 4.9 percent for girls, where as, overweight prevalence was 14 percent for boys and 17.9 percent for girls. In Kenya, there is limited information on the prevalence of childhood overweight and obesity.

On the prevalence of overweight and obesity, Lohman (1987) indicates that it increases with age in both females and males, and there is a greater probability that obesity beginning in early childhood will persist through the life span. Stettler et al. 2002 and McArdle, Katch and Katch (2000) note that, overweight and obesity frequently begin in childhood and that these children's chances of becoming obese adults increase 3-fold compared with children of normal body mass. Similarly, WHO (1998), notes that early obesity leads to an increased likelihood of obesity in later life as well as an increased prevalence to obesity related disorders.

Data from a number of studies provide strong evidence that higher levels of BMI during childhood can predict overweight and obesity conditions later in life. For instance, Goron (2001) reviewed data from four longitudinal studies and showed that the probability of overweight at 35-years of age for children with BMI in the 85th to 95th percentiles increased with increasing age. He further indicated that the prediction for adult weight was most accurate for BMI at 18 years of age with accuracy decreasing for BMI below 13 years of age. Goron (2001) therefore concluded that the persistence of pediatrics' obesity into adulthood increases according to age at which obesity is initially present. Findings presented by WHO (1998) of a study conducted in Japan between 1974 and 1993 among school children aged 6 to 14 years showed that approximately one third of obese children grew into obese adults.

Similarly, Must, Jaccques, Dallal, Bajema and Dietz (1992) presented data relating to the outcomes of overweight adolescents who were followed up to 50 years. Both men and women who were overweight at adolescence had increased age-specific morbidity and mortality relating to cardiovascular and other chronic diseases. These findings suggest that overweight and obesity during childhood and adolescence may trigger health conditions associated with adverse risk in adulthood. This then justifies the need for a study to establish the prevalence of overweight and obesity amongst school children in Kenya with the aim of providing an intervention measure.

According to WHO (1998), there is a wide variety of intervention measures available in management of obesity. These include dietary management, physical activity, behaviour modification, pharmacological intervention and surgery. However, WHO (1998) indicates that since there is need to control promotion of dangerous and deliberately deceptive approaches to weight control such as special weight-loss aids, drugs and treatments often offered through unlicensed weight-loss–centers, dietary factors and physical activity patterns are considered the major modifiable factors explaining excessive weight gain which, if corrected, can serve to prevent or manage obesity.

Exercise is necessary to maintain weight and to redistribute body fat (Moran and Arizona 1999). The same authors recommended aerobic exercises for such benefits to be achieved. In addition, Gelder and Marks (1987), and Bishop (1999), indicate that, aerobic dance exercises provide a good workout, as well as a friendly, motivational and enjoyable atmosphere to the participants especially given its use of music. Bishop (1999) further notes that, aerobic dance is significantly important for it forces greater use of large muscle groups. Unfortunately, it is not provided for in the current primary schools' physical education curriculum in Kenya.

1.2 Statement of the problem

Obesity has been recognized as an important global health issue (Bellizzi and Dietz, 1999). This is because the prevalence of obesity is on the rise hence increasing the risk of developing a number of health conditions, such as heart disease, high cholesterol and high blood pressure among others. The most immediate consequence of obesity as perceived by the children themselves is social discrimination with poor self-esteem and depression (Scottish Intercollegiate Guidelines Network [SIGN], 2003).

According to Power and Parsons (2000), the marked rise in the prevalence of overweight and obesity has coincided with major change in how children spend their time, resulting in both a decrease in physical activity and a rise in sedentary behaviour. This has been attributed to the loss of school playing fields, the lack of a safe environment in which to walk or cycle to school or for physical play at home. Additionally, there have been transport policies that favor driving above cycling and walking as well as a food industry that targets children with advertisements for high-energy foods.

The process of modernization and economic transition has seen most countries move towards industrialization and an economy based trade within the global market, which has brought about improved standards of living WHO (1998). However, this transition has also led to negative consequences on nutritional and physical activity patterns that contribute to development of overweight and obesity. Society has become very sedentary with television, computers and video games contributing to children's inactive lifestyles.

Nairobi Province is a metropolitan city whose section of the population is rapidly adopting a lifestyle that is in tune with modern society (Wikipendia, 2008). According to WHO (1998), a modern society is characterized by urban residence with facilitated transport and increasingly reduced physical activity which are some of the risk factors to development of overweight and obesity. This being the situation, there was need to provide information on prevalence of overweight and obesity amongst children in Nairobi province. Since there is a relationship between childhood obesity and adulthood obesity, it was necessary to assess if an intervention measure through exercise during childhood would have any significant effect in managing overweight and obesity. This would help to prevent the carry over of overweight and obesity from childhood into adulthood. This aim was achieved by providing a 10 weeks aerobic dance exercise programme to those pupils who were found to be overweight and obese.

According to Gelder and Marks (1987), aerobic exercises provide an enjoyable atmosphere to the participants, can be conducted indoors or outdoors and force greater use of large muscle groups. This being the case, aerobic dance exercises were used since various researchers have found them to be potent in managing overweight and obesity. For instance Sothern, Loftin, Udall, Suskid, Ewing and Tang (2000), observed that pre-adolescent obese children had their weight percent of ideal body weight and BMI reduced after they were involved in a 10 weeks low-impact aerobic dance programme. Therefore, there was need to evaluate if such beneficial outcomes could result by conducting an aerobic dance exercise programme on Kenyan children, especially given the fact that aerobic dance exercises are not currently provided for in the existing primary schools physical education curriculum.

Additionally, given the limitations of various overweight and obesity assessment techniques, yet there is the need to conduct regular assessments in a field based setting; there was the need of establishing the reliability of BIA for this purpose. This owes to the fact that BIA is simple to administer, requires inexpensive equipment, is non-invasive, requires no specialized training to administer and can be used on all populations.

1.3 Purpose of the study

The purpose of this study was to establish the prevalence of overweight and obesity among primary school children aged between 10 to 15 years in Nairobi province, Kenya. The prevalence was established using BMI based on gender, age and type of school. An analysis on the congruence amongst BMI, BIA and skin fold calipers as methods of assessing overweight and obesity in primary school children aged 10 to 15 years in Nairobi province was also conducted. Additionally, the investigator used a 10-week aerobic dance exercise programme to provide intervention in the management of overweight and obesity amongst these children.

1.4 Research objectives

The study aimed at assessing the prevalence of overweight and obesity, influence of aerobic dance exercises on overweight and obesity and establishing the congruence of BMI, BIA and skin fold calipers in estimating overweight and obesity amongst primary school children aged 10 to 15 years in Nairobi province, Kenya.

The study was therefore guided by the following specific objectives.

i. To establish the prevalence of overweight and obesity using BMI for both male and female primary school children aged between 10-15 years in Nairobi province.

ii. To determine the group that is most susceptible to overweight and obesity (either male or females).

iii. To establish if there are any differences in overweight and obesity between children in public and private primary schools.

iv. To establish the effects of age on overweight and obesity amongst primary school children.

v. To analyse the congruence amongst BMI, BIA and skin fold calipers in estimating overweight and obesity among primary school children.

vi. To assess the effect of a 10 weeks aerobic dance exercise programme on overweight and obesity of the primary school children.

1.5 Research hypotheses

The study hypotheses were that gender, age and type of school do not influence overweight and obesity status of children aged 10-15 years in Nairobi province, Kenya. The study also hypothesized that the three methods of estimating overweight and obesity namely BMI, BIA and skin fold thickness are not related. A further hypothesis was that involvement in aerobic dance exercises for a period of 10 weeks does- not provide any valuable intervention in the management of overweight and obesity among primary school children aged 10-15 years in Nairobi province, Kenya.

For testing purpose, it was further hypothesized that:

$H0_1$ There would be no significant difference in BMI between female and male children aged between 10- 15 years.

$H0_2$ There would be no significant difference in BMI between males in private primary schools and males in public primary schools.

$H0_3$ There would be no significant difference in BMI between females in private primary schools and females in public primary schools.

$H0_4$ There would be no significant difference in BMI of male and female pupils amongst the six age groups.

$H0_5$ There would be no significant relationship amongst BMI, BIA and skin fold measures in estimating overweight and obesity among children aged 10-15 years.

$H0_6$ There would be no significant difference in overweight and obesity status of children aged 10-15 years before and after participation in aerobic dance exercise programme for a period of 10 weeks.

1.6 Significance of the study

The prevalence of overweight and obesity amongst children is increasing to pandemic proportions worldwide and it is not limited to developed countries since research has indicted a growing prevalence even in developing countries (Deckelbaum and Williams, 2001). Specialists in Kenya have observed increasing incidence of obesity amongst Kenyans (Muriuki (Ed.) 2004). However, specific studies had hardly been carried out to establish the prevalence of childhood overweight and obesity in Kenya as at the time this study was conducted. There are various intervention measures available for management of overweight and obesity as indicated by the WHO (1998), but none of them had been tried on the Kenyan populations especially amongst children.

Because of the consequences of obesity to health, this study sought to establish the prevalence of overweight and obesity amongst primary school children in Nairobi province where the population is more susceptible to the vagaries of modern lifestyles. The study also aimed at assessing the efficacy of a 10-week aerobic dance exercise program as an intervention measure for management of overweight and obesity among the children.

The use of the leg-to-leg bioelectrical impedance alongside BMI and skin fold methods in estimating overweight an obesity among children aged 10-15 years in Nairobi province Kenya, would help to popularize it in schools, health clinics and fitness centers in Kenya. The information provided in this study would also be useful to students and fitness instructors who may wish to replicate the study in various academic and professional settings. This study also spearheads further research in the area of overweight and obesity especially among different populations living at different locations in Kenya and the East Africa sub-region. The findings of this study would also act as a guide to physical education curriculum developers for designing a curriculum that incorporates physical activities, which are geared towards managing overweight and obesity among primary school children in Kenya. This can in turn help to improve the children's academic performance due to enhanced self esteem as well as the alleviation of overweight and obesity related conditions which cause pupils to be prone to illness and consequently be absent from school frequently.

1.7 Limitations of the study

This study was carried out under the following constraints.

1. The researcher had no control over the pupils' heredity. Heredity is one of the determinants of overweight and obesity, but since the scope of heredity would have involved analysis of genes, this was not included a variable in the study given the limitations of conducting a genes analysis in a Kenyan situation.

2. Similarly, the researcher did not have control over the pupils' family background. Again the role of family background in terms of their social economic status in determining overweight and obesity cannot be under estimated. This also affects the lifestyle of children in terms of their levels of activity as well as their feeding habits.

1.8 Delimitations of the study

The scope of the study covered the following areas.

1. The study was delimited to primary school children aged 10-15 years in private and public schools in Nairobi province only. This is because it was possible to get a representative sample of children from school since most of

them attend school. Again age 10 to 15 was ideal for the study since it is the period when children are undergoing a lot of physiological changes in their development, which can predispose them to future overweight and obesity.

2. The study was also confined into assessing prevalence of overweight and obesity using the three body composition assessment methods namely; BMI, BIA, and skin fold measures. This was due to the need of establishing the reliability of BIA against BMI and skin fold methods in assessing overweight and obesity amongst children in a Kenyan situation.

3. Additionally, the study was confined to the use of aerobic dance exercise only as an intervention measure in the management of overweight and obesity. This was done since aerobic dance exercises provides a good work out that not only helps in energy expenditure but also provides an enjoyable atmosphere that is motivating to the pupils hence reduces cases of boredom and probably pulling out of the exercise program. Furthermore, because of loss of playing fields required for most physical activities, aerobic dance exercises were preferable since they require less space and can even be conducted indoors.

1.9 Assumptions of the study

The study was based on the following assumptions.

1. It was carried out under the assumption that nutritional level of the children did not have any effect on overweight and obesity status of primary school children aged 10 to 15 years, hence their levels of overweight and obesity was

attributed to the r lack of involvement in physical activities which could have resulted in a positive energy balance.

2. The study also assumed that other activities in which the pupils were involved in whether in school or after school other than aerobic dance exercises did not elicit any considerable effect on their overweight and obesity status during the treatment period.

1.10 Theoretical framework

This study was based on the fat cell theory, which states that obesity is as a result of both increases in number of fat cells as well as increase in the size of fat cells due to accumulation of fat deposits. This theory as expounded by Jade, (1999) and Foss and Keteyian (1998), implies that adipose tissue is increased by filling the existing fat cells with fat (adipose hypertrophy) and /or by increasing the total number of fat cells (adipose hyperplasia) which results into increased BMI. Proponents of this theory argue that there is an increased number and size of adipose cells in obese individuals. Once the fat cells develop, they never decrease in number, but they may shrink in size if the stores of extra fat are decreased through exercise (Bruess and Richardson, 1993).

According to Plowman and Smith (1997), there are about 30 to 50 billion fat cells in an adult of acceptable weight. Plowman and Smith (1997) further indicate that females have approximately 50 % more fat cells than males. Brooks and Faney (1984) contend that adipocytes can change in size (hypertrophy) about ten fold if needed to store triglycerides. Brooks and Faney (1984) further indicate that this increase in size is the way in which increasing levels of fat are first stored. Additionally, once the upper limit of fat storage by hypertrophy is approached, hyperplasia of fat cells occur which involves an increase in the number of fat cells. The theory that explains this phenomenon is the fat cell theory. This theory is as shown in Figure 1.1.

Figure 1.1 below shows that obesity is present due to the increase in number of fat cells (adipose hyperplasia) or increase in the size of fat cells (adipose hypertrophy). The figure also shows that these two conditions are as a result of overeating, inactivity or physiological predisposition in terms of age and sex. Figure 1.1 further shows that involvement in exercise can reduce the size and number of the fat cells resulting in attainment of normal weight.

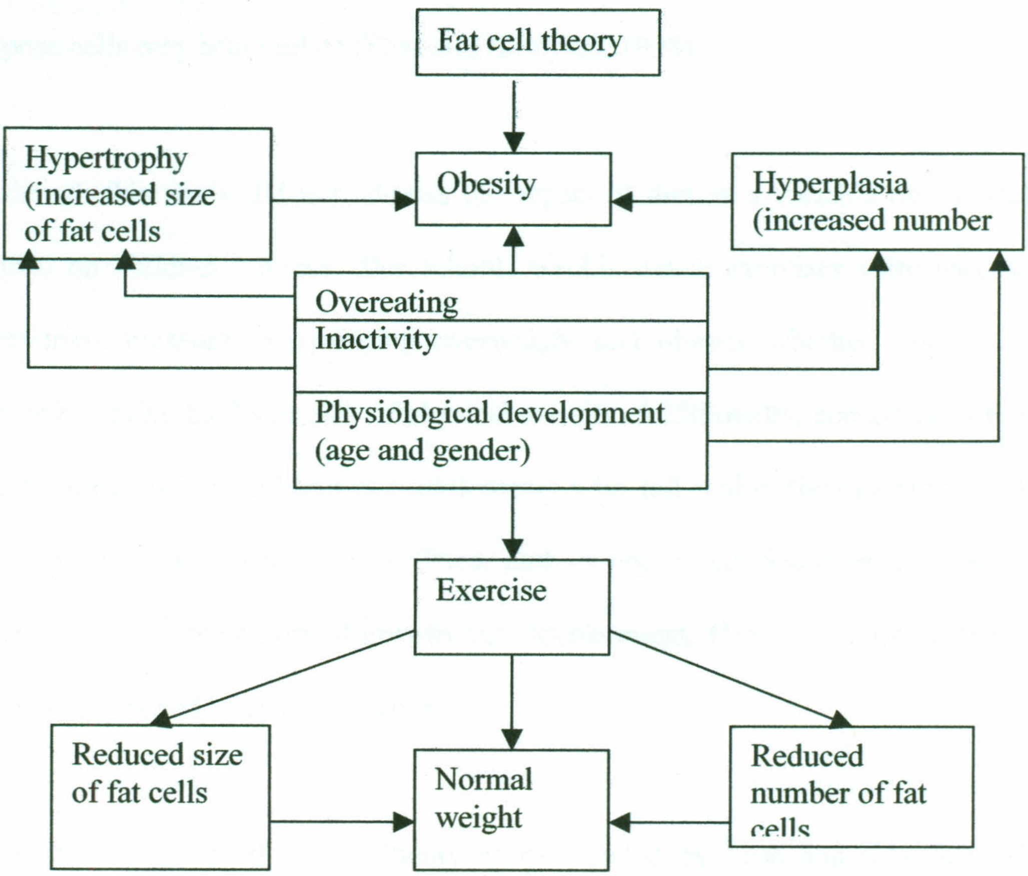

Figure 1.1 Fat cell theory adapted from Foss and Keteyian, (1998, page, 394).

From one year to the onset of puberty there is no significant increase in size of the adipocytes and there is no significant difference in sex (Plowman and Smith, 1997). Plowman and Smith (1997) however indicate that at puberty the cellularity of adipose tissue increases greatly in both males and females, but the female increase exceeds that of males. Consequently, this increase in fat cell number plateaus in late adolescence and early adulthood and ideally remains at that level. Therefore, this study aimed at assessing if there are differences in body fat between males and female aged 10 to 15 years, which is the apparent age at which puberty sets in. According to Foss and Keteyian (1998), fat cells increase both in number and size through early adolescence. Evidence suggests that, overeating during this period may cause adipose hyperplasia thus cultivating the garden in which obesity may grow and blossom. However, exercise keeps total body fat content low and may reduce the rate at which adipose cells may accumulate (Foss and Keteyian, 1998).

Although this study did not address the aspect of diet as a variable due to lack of control on children's meals after school, aerobic dance exercises were used as an intervening measure to managing overweight and obesity whether arising due to unhealthy eating habits or lack of physical activity. Additionally, according to Powers and Parsons (2000), children and adolescents who fall within the age bracket of the study (10-15 years) need to grow. These authors argue that dietary energy restriction must not compromise normal growth and development. Hence exercise is their only solution to desired body composition.

This study was based on the theory as expounded by Foss and Keteyian (1998) which states that, obesity is as a result of both increases in number of fat cells as well as increase in the size of fat cells due to accumulation of fat deposits. This was determined using overweight and obesity assessment methods of BMI, BIA and skin fold thickness. This condition can be prevented through regular physical activities; hence aerobic dance exercises were administered to children for a period of 10 weeks in order to establish if they could provide a valuable intervention in managing overweight and obesity that could have resulted due to either hyperplasia, hypertrophy or both in the fat cells.

1.11 Operational definition of terms

The following terms are defined in the context of this study

Child: A male or female who is aged between 10 and 15 years and is in a private or public primary school in Nairobi Province, Kenya.

Aerobic Activity: A mode of exercise that raises the heart rate over 50% of its maximum rate and uses large muscles continuously and rhythmically for at least 15 minutes

Aerobic Dance: A mode of aerobic exercise using music that was administered to children lasting for one hour, three times per week for ten weeks.

Exercise: Any bodily movement produced by the skeletal muscles during aerobic dance that resulted in an expenditure of energy, hence utilization of body fats.

Obesity: BMI in children above the 96^{th} percentile on the WHO (2007) percentile ranks.

Overweight: BMI in children between the 86^{th} and 95^{th} percentiles on the WHO (2007) percentile ranks.

Private Primary School: Any non-public primary school, which therefore is individually run or managed by an organization. in Nairobi province.

Public Primary School: any government's run institution in Nairobi Province set up to give basic education.

Treatment: Aerobic dance lasting one hour and offered 3 times a week for ten weeks that was administered to overweight and obese children in primary schools in Nairobi province.

Prevalence: existence of overweight and obesity amongst primary school children in Nairobi province, Kenya.

Intervention: Involvement of primary school children in Nairobi province in a 10-weeks aerobic dance exercise programme.

Management: controlling overweight and obesity among primary school children in Nairobi province, Kenya through aerobics dance exercises.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter includes a review of related literature on factors that determine overweight and obesity, assessment of overweight and obesity, effects of overweight and obesity on health, treatment of obesity, and global prevalence of obesity. Eventually the chapter is concluded with a summary of all the literature that was reviewed.

2.2 Factors that determine overweight and obesity

Howley and Powers (2001), indicate that obesity has multi-causative factors rather than a single cause. The causative factors could be genetic, environmental, sex and age.

2.2.1 Heredity

According to WHO (1998), obesity is commonly recognized as a complex multifactorial condition. Obesity results from lifestyle, which promotes a positive energy balance. Obesity as a condition also manifests more readily in people who have an inherited susceptibility to be in positive energy balance. Ted and Andrews (1999) examined the medical records of parents and children in an effort to determine the factors that lead to obesity in young adulthood aged between 21 and 29 years. The factors considered were the person's status in childhood and parents' obesity status. The study indicated that, before the age of 5 years, the primary predictor of obesity in young adulthood is the obesity of the parents. For age 6 to 9 years, both childhood and parental obesity are related to adulthood obesity. For ages 10 to 17 years, the obesity status of the child becomes a dramatic determinant of adulthood obesity.

There is increasing evidence of a genetic relationship to body fatness (Bruess and Richardson, 1993). These authors reviewed studies involving identical twins, which indicated that genetic influences on BMI are substantial, and that childhood environment has little or no influence on this. However, (WHO, 1998) disagrees on the sentiment by Bruess and Richardson (1993) that childhood environment has little or no influence on overweight and obesity. According to WHO (1998), no two obese individuals are the same. This is because there are differences in both their degree and regional distribution of excess body fat as well as in the fat topography response to factors, which promote weight gain. Such differences are not only due to genetic variation but also to prior experiences and environments to which the individuals have been exposed (WHO 1998).

Where as heredity has a role to play in determining an individuals overweight and obesity status, the scope of this study was limited in that it would have required genetic analysis for further assessment of the relationship of obesity and genes. Hence heredity was not used as a variable in the study.

2.2.2 Environment

Howley and Franks (1997) observe that people make health-related decisions based on their environment or community. Howley and Franks (1997) explain that communities, homes and workplaces each shape health decisions in the sense that with fewer options for physical activity and healthy eating, it becomes more difficult for people to make good choices. According to WHO (1998), family environment is one of the strongest influences on a child's risk to overweight and obesity. Flodmark (1993) and Wadden, Foster and Letiza (1994) observed improved weight loss or weight maintenance in children aged between 10 and 11 years treated with family therapy when compared to those treated alone. Epstein (1994) conducted a more detailed analysis on family based programmes and suggested that weight regulation effects are improved if at least one parent is included with the child treatment. In his study, Epstein (1994) found that when the effect of targeting an overweight child alone was compared with that of targeting a child and a parent together, the latter group showed significantly less weight gain at five years follow-up and were still below the relative weight at which they started the study at 10 years follow-up. Furthermore, children of non-obese parents were better able to obtain and maintain reductions in relative weight.

Since the researcher had no control over the child's family environment, the study was limited to school environment. This is because a large proportion of children in Kenya attend school especially with the introduction of free primary education and a great deal of a child's eating and exercise is carried out in this setting.

2.2.3 Sex

There are a number of physiological processes that contribute to an increased storage of fats in females and that such deposits are essential in ensuring female reproductive capacity (WHO, 1998). Payn and Isaacs (1999) also indicate that girls exhibit a stronger prevalence to carbohydrates prior to puberty while boys prefer protein. Payne and Isaacs (1999) further note that after puberty however, both males and females display a marked increase in appetite for fat in response to changes in gonadal steroid levels. However this rise in fat appetite occurs much earlier and to a greater extent in females. Consequently, females have a tendency to channel extra energy into fat storage while males utilize more of this energy for protein synthesis. According to WHO (1998), this pattern of energy usage in females contribute to further positive energy balance and fat deposition. This is because the storage of fat is more energy-efficient than that of protein and it will lead to a lowering of the lean-to-fat tissue ratio with the result that RMR does not increase at the same rate as body mass.

Majority of studies conducted amongst children support the above sentiments that gender determines an individual's predisposition to overweight and obesity. For instance a study conducted by Armstrong et al. (2006) aimed at determining the prevalence of overweight and obesity in a sample of South African children aged between 6 to 13 years. It involved sampling the schools within each province and social economic category. 10,195 primary school children (5611 males and 4584 females) from 5 South African provinces formed the sample of the study. Cut off points for BMI defining obese and overweight for gender and age were calculated in accordance with international standards. The results indicated that the prevalence of obesity within the samples was 3.2 percent for boys and 4.9 percent for girls, whereas overweight prevalence was 14.0 percent for boys and 17.9 percent for girls.

From these findings it was evident that girls of this age group showed greater prevalence to overweight and obesity than boys. Rao, Kanade and Apte in China in 2008, conducted study whose aim was to examine the concordance between various

2.3 Assessment of overweight and obesity

The following have been identified as methods of assessing overweight and obesity by various authors.

2.3.1 Hydrostatic weighing

According to Foss and Keteyian (1998), hydrostatic weighing is one of the most common means for estimating body composition in research settings and is often used as the criterion method for assessing body fat percentage. According to Powers and Howley (1997, 2001), underwater weighing procedure is based on the fact that density is equal to mass divided by volume (d=m/v). It applies Archimede's principle, which states that when an object is placed in water it is buoyed up by a counterforce equal to the water it displaces. The weight of water displaced is converted to a volume by dividing by the density of the water (DW) at the time of measurement D=M/V=MA/(MA-MW)/dw The denominator must be corrected for two other volumes: the volume of air in the lungs at the time of measurement and the volume of gas in the gastrointestinal tract.

Powers and Howley (2001) observe that underwater weighing procedure, in which the residual volume is measured, has been used as the standard against which other methods are compared. Payne and Hahn (2002) however note that, although a "gold standard" for body composition assessment, underwater weighing is time consuming, requires sophisticated equipment and personnel and that most individuals are not comfortable while immersed in water. Additionally Goss et al. (2003) indicate that, this technique is contraindicated or impractical in certain clinical subgroups, such as the elderly, individuals with cardiopulmonary disease or hypertension, subjects who are uncomfortable being immersed in water and children.

Consequently, this body composition assessment procedure was presented due to the fact that the equations for calculating body density hence body fat for skin fold measures that were used in the study are derived from this procedure. However, because of its limitations in terms of cost, time and unavailability of equipment and personnel in a Kenyan set up, the procedure could not be used to assess body composition of the subjects of the study. Thus alternate body composition assessment techniques that are easier and safer to administer were used which included BMI, BIA system and skin fold calipers.

2.3.2 Body mass index (BMI)

BMI is a descriptive measure of the degree of overweight and obesity in children and adults (Ponder and Anderson 2007). It is calculated as the weight in kilograms divided by the square of the height in meters (kg/m^2) (WHO, 1998). According to Ponder and Anderson (2007) BMI, is limited by the fact that it is unable to distinguish the amount of fat mass compared to lean mass. These authors explain that this is due to the fact that individuals with hypertrophied skeletal muscle such as a very muscular athlete or an athletic child would have a high BMI despite having a low percentage of body fat. According to DHHSCDCP (2007), although BMI does not measure body fat directly, research has shown that it correlates to direct measures of body fat such as underwater weighing and dual X-ray absorptiometry (DXA). The DHHSCDCP (2007) indicate that BMI is an inexpensive and easy to perform method of screening for weight categories that may lead to health problems for children and teenagers. The Department further notes that BMI is age specific. Upon calculating the BMI score, the score is plotted on the BMI- for –age growth charts (for either girls or boys) to obtain a percentile ranking. The percentile indicates the relative position of the child's BMI score among children of the same age and sex. The growth charts show the weight status categories used with children and teenagers (underweight, healthy weight, overweight and obese). According to WHO (2007), the following are the BMI-for-age weight status categories and corresponding percentiles.

Table 2.1: BMI-for-age weight status

Weight status category	Percentile range
Underweight	Less than the 5^{th} percentile
Healthy (normal) weight	5^{th} percentile to less than the 85^{th} percentile
Overweight	85^{th} to less than 95^{th} percentile
Obese	Equal to or greater than the 95^{th} percentile

Given the inability of BMI to measure body fat directly, those pupils who were found to be overweight or obese using BMI were put into further assessment with BIA system and skin fold measures for reliability purposes.

2.3.3 Bioelectrical impedance analysis (BIA)

According to Utter, Nieman, Ward and Butterworth (1999), the leg-to-leg BIA system is a valid and reliable method of assessing percent body fat. These authors further indicate that it is a relatively simple, quick, portable, noninvasive method that is currently used in diverse settings including private clinicians' offices, wellness centers and hospitals). BIA system involves placing electrodes on the ear and toe of a subject who is resting in a supine position. An alternating, sub threshold current (less than 1 mA) is then transmitted through the body (Goss et al. 2003 and ISAK, 2001).

The basic premise of this technique is that lean tissue acts as an electrical conductor while fat resists the transmission of the electrical impulse. Goss et al. (2003) indicate that a recently developed BIA system obviates the need to employ cutaneous electrodes but employs a leg- to- leg electrode system requiring approximately 8 seconds to administer.

Utter et al. (1999) carried out a study that aimed at determining the validity of the leg-to-leg BIA system in estimating body composition in obese and non-obese women. The study also was set to assess changes in body composition in obese women in response to 12 weeks of energy restriction, exercise training or both. The subjects included 98 moderately obese women (43.2 ± 0.6% body fat, 45.0 ± 1.1 years of age) and 27 non-obese control subjects (24.0 ±1.5% body fat, 43.5 ± 2.5 years of age). Obese subjects were randomly divided into 1 of 4 groups with fat free-mass, fat mass and percentage body fat estimated with BIA and underwater weighing before and after 12 weeks of intervention. The four groups were diet only (4.19-5.44 milijoules per day), exercise only (five, 45 minutes sessions per week at 78.5 ± 0.5% of maximum heart rate), both exercise and diet and control (no diet or exercise).

The results of the study indicated that no significant difference was found between under water weighing and BIA in estimating the fat free mass of the obese and non obese women (all subjects combined, ($r = 0.78$, $p < 0.001$, SEE= 3.7kg) or in estimating decrease in fat during 12 weeks of energy restriction, exercise or both in obese subjects.

From the study, it was concluded that the leg-to-leg BIA system accurately assessed fat free mass in obese and non-obese women and changes in fat mass with diet alone or when combined with exercise. Their study however used the adult population, thus a study was needed to establish whether a similar congruence exits in children population in Nairobi province, Kenya.

In a different study, Goss et al. (2003) carried out a study that aimed at investigating the congruence between skin folds and bioelectrical impedance in assessing percent body fat in children. The sample for the study comprised of 162 female and 160 male children aged between 10-15 years. Skin fold measures obtained at the triceps and medial calf and leg-to-leg bioelectrical impedance system were used to determine percent body fat using child specific equations. Pearson product moment correlations were performed on percent fat values obtained using skin folds and bioelectrical impedance for the entire data set. Separate correlations were also conducted on gender and age subsets. Dependant t- tests were used to compare the two techniques.

The results indicated that, percent body fat did not differ between skin folds and bioelectrical impedance for the total subject pool. The results also showed that bioelectrical impedance overestimated percent fat in girls by 2.6 percent and underestimated percent body fat in boys by 1.7 percent ($p < 0.01$). Correlations between skin folds and bioelectrical impedance ranged from $r=0.51$ to $r= 0.90$.

The study concluded that leg-to-leg bioelectrical impedance might be a viable alternative field assessment technique that is comparable to skin folds. The reviewed studies were however carried out in America. However, the current study aimed at investigating the accuracy of using BIA in estimating overweight and obesity among Kenyan children. This was done when leg-to-leg BIA system was compared against BMI and skin fold methods.

2.3.4 Skin folds thickness

According to Franks and Howley (1997), this measure is based on the assumption that, as one gains adipose tissue, the increase in skin fold thickness will be proportional to the additional fat weight. Additionally, according to Powers and Howley (1997), skin fold method relies on the observation that within any population a certain fraction of the total body fat lies just under the skin and if one could obtain a representative sample of that fat, overall body fatness could be predicted. According to Getchell, Mikesky and Mikesky (1998), skin fold measures should be taken on the right side of the individual's body while standing. At the appropriate site, a fold of the skin is grasped using the thumb and the forefinger of the tester's left hand. Most of the skin folds taken at the different sites are either vertical or diagonal. The sites on which skin fold measures are taken for girls are different from those of the boys and are shown in appendix A. An average of three measures on each site is then determined and then added together to obtain the sum of the skin fold measures. The sum of skin fold measures is used to calculate body density in the equations shown in appendices B and C for females and males respectively. The obtained body density in then used in the Siri equation (530/ Density - 489) to determine percent body fat for children.

2.4 Effects of obesity on health

The health consequences of obesity include non-fatal complaints that impact on the quality of life such as respiratory difficulties, musculo-skeletal problems, skin problems and infertility. Other consequences which may lead to an increased risk to premature death include non-insulin dependant diabetes, gall bladder disease, cardiovascular problems and cancers, which are hormone related and associated with the large bowel (Payne and Hahn, 2002).

Howley and Powers (2001) reviewed a heart study and indicated that relative weight is positively related to high serum triglycerides, total cholesterol (with lower high density lipoproteins) and uric acid, elevated blood pressure and a greater degree of glucose intolerance.

Similarly, Colon et al. (2003) conducted a study aimed at estimating the prevalence of obesity in school-aged children, determining the susceptible groups and to study the association between obesity and blood pressure. During the school year, 5,953 children aged 5-11 years were screened for weight, height and BP using the standardized techniques. The results indicated that obesity was significantly greater in girls than in boys. The results also indicated that, the systolic and diastolic BP were significantly higher in obese than in non-obese children. This study recommended further investigations into prevention programs that could be used in the school setting. The current study therefore aimed at establishing if aerobic dance exercises would have any effect on body composition of the children aged 10-15 years in Nairobi province, Kenya.

2.5 Management of overweight and obesity

There is a wide variety of therapies available for treatment of obesity (WHO 1998). They include dietary management, physical activity, behaviour modification, pharmacological treatment and surgery.

2.5.1 Dietary management

Dietary restriction represents the most conventional treatment for overweight and obesity. According to WHO (1998), it induces weight loss in short term. However there are diets based on healthy eating principles, which include modest energy deficit diet and low fat diet that have long term out come on weight management. The World Health Organization (1998) however warns that the use of dieting as a weight management strategy is limited by the fact that when used in isolation, it has a poor long-term effectiveness.

2.5.2 Physical activity

Cross-sectional data often reveals an inverse relationship between BMI and physical activity indicating that obese and overweight subjects are less active than their lean counterparts (WHO, 1998). McArdrdle, Katch and Katch (1986) contend that physical activity patterns influence the physiological regulation of body weight. Additionally, Malla (2004) notes that the level of participation in various physical activities may affect food consumption and basal metabolic rate of an individual, which are some of the indicators of obesity. According to WHO (1998), physical activity particularly affect total energy expenditure from the body as well as regulating fat cell production.

2.5.2.1 Physical activity and energy expenditure

Howley and Powers (2001) note that physical activity constitutes the most valuable part of energy expenditure side of the energy balance at a rate of about 5% to 40% of the daily energy expenditure. According to Howley and Powers (2001), there exists an inverse association between physical activity and body weight, with body fat being more favorably distributed in those who are physically active. According to WHO (1998), analysis of over 40 national physical activity studies worldwide show that there is a significant relationship between the average BMI of adult men and their PAL, with the likelihood of becoming overweight being substantially reduced at PALS of 1.8 or above. Additionally, WHO (1998) indicates that energy requirements increase from the basal levels immediately after the initiation of physical activity. WHO (1998) further indicates that the total amounts of energy expended depend on the mode, intensity, duration and frequency of the physical activity.

Research has shown that at least three days of training per week are required to bring about changes in body composition through exercise. According to McArdle et al. (1986), it is recommended that the calorie burning effect of each exercise cession should be at least 300 kilocalories. McArdle et al. (1986) further suggest that this can be achieved within 20-30 minutes of moderate to vigorous running, swimming, cycling or walking for 40-60 minutes. Foss and Keteyian (1998) indicate that regular aerobic exercises even without dietary restriction bring about favorable changes in body weight and body composition. If exercise is vigorous, oxygen consumption remain elevated above the resting levels for some time even after the cessation of the activity. According to (WHO, 1998), this accounts for the extra energy expended and is potentially helpful in maintaining energy balance especially if exercise is undertaken regularly. (WHO, 1998) further indicates that in addition to the immediate energy costs of increased physical activity and of the recovery period, habitual exercise also influences the resting metabolic rate (RMR).

The importance of exercise duration for weight loss is illustrated by a study reviewed by McArdle et al. (1986) of three groups of men who exercised for twenty weeks by walking and running for either 12,30 or 45 minutes per session. The results indicated that compared to a sedentary control group, the three exercise groups significantly decreased their body fat, fat folds and waist girth. When comparisons were made between the three groups, the 45-minute training group lost more body fat than either the 30 minutes or 15 minutes group. This was attributed to the greater caloric expenditure of the longer exercise duration time.

2.5.2.2 Physical activity and production of fat cells

Exercise results in production of fewer fat cells during the growth years and shrinking of fat cells during the adult years (Foss and Keteyian, 1998). According to Davis and Stone (1993), the number of fat cells in the human body grows rapidly during the last trimester of pregnancy, the first year of life and in the adolescent growth spurt. In addition, Housh and Housh (2000) note that fat cells accumulate in childhood and adolescence. These authors suggest that exercise is important in preventing obesity during these years especially given the fact that overweight and obesity at these stages are significant predictors of overweight and obesity in later life

Bunkoff and Moutinho (2004) indicate that a crucial time for obesity is between the first and second years of development. The authors estimated obesity in a group of

155 pre-school children (F=75, M=80) aged 4-5years from a municipal institution in Capinas City Brazil. The study used anthropometric measures of weight and height. The results of the study indicated that approximately 10 cases in the female and male groups were obese. Davis and Stone (1993), however suggest that diet control and exercise at these stages can result in the formation of fewer permanent fat cells.

Burgess, Grogan and Burwitz (2005) note that overweight and obesity are easier to prevent than to treat. These authors suggest that adopting a formal exercise program or simply becoming more active is valuable to burn fat. Allison, Frontaine, Manson, Stevens and Vanitallie (1999) reviewed studies that supported participation in physical activities in increasing adolescents' self esteem and reducing anxiety and stress which are among the effects of overweight and obesity on the health status of a child. However, Ponder and Anderson (2007), indicate that most studies of children have not shown exercise to be a successful strategy for weight loss unless coupled with another intervention such as nutrition education or behaviour modification.

These observations by Ponder and Anderson (2007) contradicted with the findings by Mo-Suwan, Pongrapai, Junjana and Puetpaiboon (1998) who conducted a study that aimed at evaluating the effect of a school-based aerobic exercise program on obesity indexes of preschool children. The subjects of the study were 292-second year elementary school pupils from 2 kindergartens in Hat Yai municipality, Songkhla province southern Thailand. A specially designed exercise program including 15-min walk before beginning the morning class and a 20-min aerobic dance session after the afternoon nap, 3 times a week was conducted for 29.6weeks. Weight, height and triceps skin fold thickness were measured 4 times. The results at the end of the study indicated that the prevalence of obesity, using 95th percentile National Centre for Health Statistics triceps skin fold thickness cutoffs of the exercise group decreased from 12.2 percent at baseline to 8.8percent The results also indicated that the exercise group had a lower likelihood of having an increasing BMI slope than the control girls did. The study therefore concluded that a 29.6 weeks school-based exercise program can prevent BMI gain and may induce a remission of obesity in preschool children.

Additionally, Burgess et al. (2005) conducted a study that aimed at investigating the effects of 6-week aerobic dance on body image dissatisfaction and physical self-perceptions resulting from overweight and obesity status in adolescent girls. The subjects of the study comprised of 50 British schoolgirls aged between 13 to 14 years. A crossover design was used with two equivalent groups being taught normal physical education and aerobic dance in a different order. The body attitude Questionnaire and children and youth physical self-perception profile were administered as pre, mid and posttest to each participant in each group before the first intervention, at change over and after 12 weeks. The results of this study revealed that participation in 6 weeks of aerobic dance exercises significantly reduced body image dissatisfaction and enhanced physical elf-perception although these improvements were not maintained.

Another study conducted by Sothern et al. (2000) indicated the value of low impact aerobics in weight management. The aim of the study was to asses the safety, feasibility and efficacy of a resistance training program in preadolescent obese children. The subjects of the study included 19 treatment subjects aged 7-12 years and 48 control subjects of the same age. The treatment group was enrolled in a 10 weeks weight management program which included diet, behaviour modification and aerobic and flexibility exercises. The control group participated in the diet and behaviour modification program. The efficacy of the overall weight management program was examined by anthropometry at 10 weeks and a follow-up after 1 year. The results indicated that weight percent of ideal body weight and BMI were reduced significantly at 10 weeks ($p<.001$) and did not increase significantly at one-year follow-up. In the treatment subjects, percent fat decreased significantly ($p<.001$) where as fat free mass did not change significantly ($p>.05$). From the study, it was concluded that low impact aerobic dance exercises are feasible in weight management in obese adolescents.

Studies reviewed by WHO (1998) also indicated that increasing physical activity through integrating regular exercise programmes into the school curricula is a strategy that has often been proposed as an effective means of improving weight and health status of children. WHO (1998) reviewed a study on evaluation of a two-year project in south Australia, where a 50 minutes session of daily physical activity was introduced into a number of primary schools. According to that study children who took part in the program were fitter, slimmer and had lower diastolic blood pressure than their non-participating counterparts. A subsequent study, which built on this project by including classroom lessons on nutrition and physical health, was also able to demonstrate improvement indices of fitness and body fat levels. According WHO (1998), similar programmes have been run in the U.S and Singapore schools where short-term results appeared promising.

According to WHO (1998), research into the value of exercise in treating childhood obesity is very limited, and much remains to be elucidated, particularly in relation to the long-term benefits of physical activity in the control of weight through childhood and adolescence. Therefore the current study aimed at assessing the effects of a 10 weeks aerobic dance program on overweight and obesity amongst children in Nairobi province, Kenya.

2.5.3 Behaviour modification

The primary goal of behaviour treatment is the improvement of eating habits and levels of physical activity (WHO 1998). The following are highlighted by WHO (1998) as the major features of behaviour therapy.

a) Self-monitoring which involves the detailed daily recording of food intake and the circumstances under which it occurs. This helps provide essential information for selecting and implementing intervention strategies. It also forms part of the behaviour change process through evaluation of progress and identification of personal and environmental influences that regulate eating and physical activity.
b) Stimulus control: This involves limiting exposure to cues that promote overeating
c) Focus on improved nutrition. Here rigid dieting is discouraged in favour of balanced and flexible food choices.
d) Cognitive restructuring. This is used to identify and modify dysfunctional thoughts and attitudes about weight regulation.

e) Interpersonal relationship: This is addressed in order to cope with specific triggers for overeating and an increased social support for weight control.

WHO (1998) however indicates that although behaviour modification therapy is effective in changing behaviour during the short term and consistently produce significant weight loss in patients with mild to moderate obesity, it is limited by its ineffectiveness in the long term. This is because individuals fail to adhere to the self-regulatory strategies they learn in treatment.

2.5.4 Pharmacological controlled treatment of obesity

Research indicates that the use of drugs in treatment of obesity is a rapidly growing field. According to WHO (1998), the use of drugs is currently undergoing reevaluation for it to be included as an acceptable long-term strategy of maintaining body weight. As such several drugs have been approved which include Dexfenfluramine, Phentermine, Ephedrine and Caffeine (WHO, 1998).

2.5.4.1 Dexfenfluramine

According to Arterbum (2006), dexfenfluramine is an anorexic (appetite suppressant) that causes the release of serotonin (a neurotransmitter) in the brain from the pre-synaptic neurons. Once released, serotonin stimulates the hypothalamus, which controls satiation, mood, sleep, body temperature and other vital functions. Myers (2004) reports on the International Dexfenfluramine (INDEX) study, which was the largest controlled study utilizing dexfenfluramine. In the study, patients were placed on either placebo (sugar pills) or dexfenfluramine for one year. Additionally, all patients were put on behaviour modification and dietary restriction programmes. Patients placed on placebo lost an average of 7.15 kilograms compared to the dexfenfluramine group, which lost an average of 9.82 kilograms. However, Myers (2004) and Payne and Hahn (2002) note that clouds are hanging on this drug since it causes serious medical conditions such as pulmonary hypertension that affects an estimated 1 in 17000 patients treated for longer than 30 months. Additionally Myers (2004) warn that high doses of dexfenfluramine have been shown to cause significant damage to brain serotonin neurons resulting in depletion of serotonin with an overall effect on sleep and mood disorders especially depression.

2.5.4.2 Phentermine

According to Arterbum (2006), phentermine suppresses appetite making an individual to feel less hungry. Payne and Hahn (2002) note that phentermine works by changing levels of brain chemicals (neurotransmitters) that affect mood and appetite and may slightly increase the rate at which the body burns calories. Arterbum (2006) reports of a study that indicated that using 15 to 30 milligrams of phentermine daily resulted in an average weight loss of about 3.6 kilograms more than when using a placebo. This research indicated that the medicine was used for 2 weeks to 24 weeks with an average use of 13 weeks. However Arterbum (2006) warn that there are side effects associated with the use of phentermine, which includes nervousness, irritability, sweating, sleep problems and addiction.

2.5.4.3 Ephedrine and Caffeine

According to Arterbum (2006), these drugs enhance the sympathetic release of catecholamines. Once released, the catecholamines increase energy expenditure by 5 to 10 percent through stimulation of the receptors in the highly specialized fat cells called brown adipose fat. These cells have more mitochondria than other fat cells, which accounts for their color.

However, WHO (1998) indicate that the use of these drugs is limited in the sense that the currently approved drug therapy work only best when used in conjunction with diet and lifestyle management. Furthermore, drugs for weight management do not cure obesity when they are discontinued since weight gain occurs.

2.5.5 Surgery

Surgery is recognized as the most effective way of reducing weight and maintaining weight loss in severely obese (BMI greater than 35) and very severely obese (with BMI greater than 40) subjects (WHO, 1998). According to WHO (1998), surgical procedures are based on the principles of restriction of energy intake and malabsorption of food. Payne and Hahn (2002) have outlined the following as some of the surgical procedures used for treating obesity.

2.5.5.1 Gastric resection

This is a major operation in which a portion of the small intestine is bypassed in an attempt to decrease the body's ability to absorb nutrients. Although this procedure can produce substantial loss of body weight; it is associated with many unpleasant and dangerous side effects (including diarrhea and liver damage) and various nutritional deficiencies.

2.5.5.2 Gastroplasty

This is a surgical procedure that involves sealing off about a half of the stomach with surgical staples. Once the procedure is has been completed, the reduced capacity of the stomach decreases the amount of food that can be processed at any one time. As a result patients feel full more quickly after eating a small meal. This procedure is reversible but carries risks associated with surgery and the costs of a major surgical procedure.

2.5.5.3 Liposuction

During this procedure the physician inserts a small tube through the skin and vacuums away adipose tissue. This procedure is generally used for stubborn, localized pockets of fat and is usually appropriate for people under the age of forty. The risk of infection, pain, discomfort, bruising, swelling, discoloration, abscesses and unattractive changes in body contours are possible outcomes of liposuction.

According to Payne and Hahn (2002), in all types of surgery, the mortality rate reported ranged between 1 death for every 100,000 cases and 1 death for every 300,000 surgical cases, while for liposuction the rate may be 20 to 60 times higher (1 death per 5,000 cases between 1995 to 1998).

2.6 Management of overweight and obesity in children

According to WHO (1998), the objectives of weight management strategies for children differ from those of adults. This is because consideration has to be given to the physical activity and intellectual development of the child. Additionally, WHO (1998) indicates that whereas adult treatment may focus on weight loss, child treatment targets prevention of weight gain. Therefore, the treatment of obese children to prevent them from becoming obese adults can be classified as targeted prevention because childhood obesity substantially increases the risk of adulthood obesity. WHO (1998) reviewed a study by Epstein (1994) that showed evidently that treatment of obesity in children can be successfully managed over the period of time from childhood through adolescence to adult hood. In the studies by Epstein (1994), 158 children who were at high risk for significant adulthood obesity were followed up 10 years after the initial treatment. At the time of the initial treatment, the children were between 6 to 12 years of age, averaged 40% to 50% overweight, and had at least one obese parent. The studies investigated different treatment conditions but all involved a diet plan together with group behaviour modification presented intensively over an 8 to 12 week period followed by monthly maintenance sessions for 6 to 12 months. After the 10 years of follow-up, six out of the nine actively treated groups showed a net reduction in percent overweight of between 10% and 20%. The three remaining groups did not succeed in the long term due to lack of focus in the interventions offered to these groups.

According to WHO (1998), treatment of childhood obesity should include a reduction in energy intake. However, only small reductions are recommended, as an adequate intake of both energy and nutrients is required by children to ensure that normal growth and development are not compromised. In addition to dietary restriction, McArdle et al. (1986) indicate that involvement in physical activity could result in weight loss due to energy expenditure. According to Payne and Hahn (2002), physical activity contributes to weight loss and maintenance of weight loss because activity burns calories. Payne and Hahn (2002) further indicate that physical activities stimulate a 12 to 24 period of sustained elevation of the BMR, which results in more calories being burned even after moderate exercise has been completed. In addition, more fat is lost following involvement in Physical activity than is lost through dieting alone (Payne and Hahn, 2002). In fact these authors indicate that weight loss achieved through physical activity is 95 percent fat and 5 percent lean tissue in comparison with the loss of 75 percent fat and 25 percent lean tissue when dieting alone is used.

According to WHO (1998) energy expenditure can be increased more effectively through increased general activity and play rather that through competitive sport and structured exercises. There is limited information regarding the use of aggressive forms of therapy such as drugs and surgery for children and adolescents. In fact, Payne and Hahn (2002) indicate that the importance of physical activity (along with sound nutrition) in prevention of obesity is especially important in children. Therefore, the present study aimed at establishing the role of exercise in managing weight amongst children aged 10 to 15 years given the fact that apart from energy expenditure, physical activity is also associated with other benefits such as increased heart and lung endurance, muscular strength, flexibility among others, hence making adherence to the weight reduction program possible especially amongst children.

2.7 Global prevalence of overweight and obesity

Overweight and obesity are independent risk factors for increased morbidity and mortality through out the lifecycle. According to Deckelbaum and Williams (2001), overweight and obesity in women are predictors of gestational diabetes during pregnancy and newborns with excessive birth weight. High birth weight is a predictor of overweight and obesity in adulthood and in cofactors associated with insulin resistance.

2.7.1 Global prevalence of adulthood overweight and obesity

According to Wolf (1998), obesity is a challenge to both developed and developing countries. In 1981, WHO released findings of a study conducted in 48 countries of the world, mainly European countries that participated in the MONICA study using BMI. The results indicated that between 50 percent and 75 percent of adults aged 35-64 were either obese or overweight during the period between 1983 and 1986.

WHO (1998) also presented results of studies conducted in African countries, which showed that, between 1987 and 1988, the prevalence of obesity amongst adults aged 20 years and above was 0.98% in both men and women in Ghana. In 1992, a study conducted in Mauritius with a population aged between 25 to 74 years using BMI indicated that 5 percent of the men and 15 percent of the women population were obese with a BMI greater than 30. In South Africa (Cape Peninsula), a study on obesity prevalence amongst blacks was conducted in 1990. The study population was aged between 15 and 64 years. The results showed that 5 percent of the men population and 44 percent of the women population were obese with a BMI greater than 30. In East Africa (Tanzania), a similar study was carried out between 1986 and 1989 on men and women aged between 35 to 64 years. The results showed that 0.6 percent of the men population and 3.6 percent of the women population were obese with a BMI greater than 30. In Kenya, Christensen et al. conducted a study in 2008. The objective of their study was to assess abdominal, visceral and subcutaneous fat thickness, prevalence of obesity and differences in body composition in rural and urban Kenya. The study was carried out using a cross-sectional design among Luo, Kamba and Maasai in rural and urban Kenya. Abdominal visceral and subcutaneous fat thicknesses were measured by ultrasonography. Height and weight, waist, mid-upper arm circumferences and triceps skin fold thickness were measured. BMI and arm fat area (AFA) and arm muscle area were calculated. Subjects for the study comprised 1430; male and females aged 17-68 years.

The results indicated that abdominal visceral and subcutaneous fat, BMI, and waist circumference increased with age and were highest in the Maasai and in the urban population. The study concluded that abdominal visceral and subcutaneous fat thickness was higher with urban residency. The study also concluded that there was a high prevalence of overweight and obesity, and that the Maasai had the highest overall fat accumulation.

2.7.2 Global prevalence of childhood overweight and obesity

The increase in overweight and obesity prevalence has been observed internationally from pre-school children to adolescence (Deckelbaum and Williams, 2001). Deckelbaum and Williams (2001) further indicate that these increases have been noted in all racial and ethnic groups, but some groups are affected more than others. WHO (1998) gave the example of USA where the prevalence of overweight and obesity (defined as the 85^{th} to 95^{th} percentiles of the weight for length growth references) among 5 to 24 year-olds from a biracial community of Louisiana (total n=11564) increased approximately twofold between 1973 and 1994. At present, nearly 8% of children between 4 to 5 years of age in the United States are overweight (Deckelbaum and Williams, 2001). According to Deckelbaum and Williams (2001), similar disturbing trends in increasing overweight and obesity are being recorded in other industrialized settings. For instance, in Japan the frequency of obese schoolchildren between the ages 6 to 14 years increased from 5 percent to 10 percent and that of extremely obese children from 1 percent to 2 percent between 1974 and 1993.

Although there is increasing prevalence of childhood overweight and obesity especially in industrialized countries this pandemic is not limited to industrialized countries only. De Onis and Blossner (2000) reviewed a study that reported rapidly increasing prevalence of overweight and obesity among preschool children in developing countries. In the review it was evident that certain countries demonstrated high percentages of overweight at the same time as high frequencies of wasted (malnourished) children were also measured. Specific examples included North Africa, where the percentage of overweight children exceeded 8% and wasted children were reported at 7%. Similarly in Eastern Asia, 4.3% of preschool children were overweight and 3.4% wasted. In South America, where malnutrition and underweight were once predominant, the percentage of overweight pre-schoolchildren was 5% but wasted children were only 1.8%. According to Deckelbaum and Williams (2001) rates of increase in childhood overweight and obesity seem most marked in countries of Northern Africa, such as Morocco and Egypt, as well as in some countries of the Caribbean and South America.

From this review, it is evident that overweight and obesity in children can no longer be classified as a Western problem alone since it is also prevalent in most developing countries. Malla (2004) conducted s study that aimed at establishing the prevalence of obesity and factors that contribute to obesity among pre- adolescents aged between 10 to 13 years in Nairobi, Kenya. The sample for the study included 120 boys and girls derived from two private schools in Nairobi. Their obesity status was established using BMI. The findings of the study indicated that BMI scores greater than 26 were observed in 38.1 percent of the total sample of the study. According to the results, overweight and obesity was prevalent among these children.

2.8 Summary

From the review of literature as well as related studies that have been conducted on the area of overweight and obesity, there are distinct gaps that the current study elicited and attempted to fill.

First, childhood overweight and obesity are not only confined to the industrialized countries, as high rates are already evident in some developing countries. However, majority of the reviewed studies with the examples of those conducted by Mo-Suwan et al. (1998), Allisons et al. (1999), Burgess et al. (2005), Utter et al. (1999), Goss et al. (2003) and Colon et al. (2003) indicate that more focus has been given to the Western countries. A few studies have been conducted in Africa with the example of the study by Armstrong et al. (2006), which was conducted in South Africa. The study conducted by Christensen et al. (2008), focused on the adult population and was only limited to three communities. However, there is no record of cutting edge studies on overweight and obesity that have been conducted on the Kenyan populations especially the school children.

The study conducted by Malla (2004) used a very small sample (120) whose results cannot be generalized to the population of school going children in Nairobi province. Additionally, the study only used BMI for estimating overweight and obesity yet this procedure is limited by the fact that it does not distinguish between weight associated with fat and weight associated with muscle. Again the study used the adult cut off points to interpret BMI hence not putting into consideration the age and sex specificity of BMI. Thus the present study aimed at establishing the prevalence of overweight and obesity amongst children in Nairobi province, Kenya.

Secondly, the studies by Bunkoff and Moutinho (2004) and Colon et al. (2003) involved the use of only BMI as a body fat assessment method to distinguish between the overweight and obese cases from the rest of the population. Putting into consideration the limitations of BMI in the inability to distinguish the amount of fat mass compared to lean mass, as well as the unavailability and complexity of the hydrostatic weighing technique, this study used skin fold measures and bioelectrical impedance analysis as complementary techniques to BMI in estimating body fat in school children. This is because according to Payne and Hahn (2002), skin fold measure and BIA analysis techniques are quick, noninvasive, inexpensive methods that provide fairly accurate assessments of body fat percentage and it is recommended that they be used alongside BMI. Furthermore, the fat percent values obtained using skin fold equations have been validated using the reliable results of the hydrostatic weighing techniques.

Third, the study by Armstrong et al. (2006) targeted school children aged between 6 to 13 years and used both boys and girls. However the growth spurt for girls is between ages 9 to 11 years and reaches the peak at age 12. On the contrary, the growth spurt for boys usually start later at age 12 and peaks at age 14. It is therefore evident that this study did not account for the gender differences in the growth spurt hence the subjects in the study did not bear similar physiological characteristics. The current study however, by using a wider range in terms of age (10 to 15) years accounted for the differences in development of both boys and girls.

The studies by Bunkoff and Moutinho (2004) and Mo-Suwan et al. (1998) were conducted on Pre School children aged 4 to 5 years. However in this age the gain in weight between boys and girls is usually uniform. Hence there is no marked gender difference in terms of body weight and height. Furthermore these are the most active years in a child's growth and developmental years hence they expend a lot of calories in play. As such chances of developing overweight and obesity at this stage are minimal compared to the adolescence stage of development that is marked by rapid growth of fat cells, changed feeding habits and irregular or no physical activities. It is for this reason therefore a study was needed in order to assess the prevalence of overweight and obesity among children aged 10 to 15 years which is apparently the adolescence stage for majority of children and for both girls and boys.

The study by Utter et al. (1999) aimed at validating the leg-to –leg BIA system with underwater weighing technique in estimating body composition. Although this was a very viable study, it was based on the adult population and was only limited to women. Since no data is available on the use of either BIA or skin fold calipers in assessing body composition of children in Kenya, a study was needed to establish the congruence among the three procedures thus popularizing either of them for use in a

Kenyan setting specifically on children. The study also focused attention on the children population since it is at this stage of development where the fat cells increase in size and number and most children tend to adopt a sedentary lifestyle as they approach adolescence, which further predisposes them to hyperplasia. Additionally, research has shown that childhood overweight and obesity can predict overweight and obesity in later life hence the need to assess the problem early enough in childhood so as to develop lifelong prevention and management strategies that will help prevent the development of overweight and obesity related disorders later in life.

Most intervention procedures such as the intestinal bypass and the use of pills that have been used to treat overweight and obesity amongst most adults are invasive and with serious side effects. Additionally, none of these treatment procedures have been authorized for children leaving dietary restriction and physical activities as the only viable alternatives for overweight and obesity prevention in children. The study by Colon et al. (2003) did not focus on the prevention programs that could be used in the school setting to help manage overweight and obesity amongst children. Mo-Suwan et al. (1998) used a 20 minute aerobic program on children as a management strategy for overweight and obesity amongst children. Although the program lasted for a long period of time (29 weeks), 20 minutes session was short to realize the physiological changes that result into weight loss especially when aerobic dance exercise are used. The recommended time is usually 60 minutes. The current study therefore used aerobic exercises that were administered to children for 60 minutes three times a week and lasted for 10 weeks as an intervention to managing overweight and obesity.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

This chapter describes the research design, research variables, location of the study, target population, sampling procedure, instrumentation, pilot study, data collection, data analysis and data presentation techniques which were used in the study as well as specific logistical and ethical considerations.

3.2 Research design

The study was carried out in two phases. The first phase involved a survey on establishing the prevalence of overweight and obesity among primary school children aged between 10 to 15 years using BMI only. In this phase a cross-sectional design was used. According to Thomas, Nelson and Silverman (2005), in cross-sectional research design, subjects are assessed at a single time. This design is less time consuming since it involves testing several age-groups at the same point in time hence a large number of subjects can be tested at a little cost (Thomas, Nelson and Silverman, 2005). Additionally, this design is not associated with the problem of subjects pulling out during the course of the study.

The second phase of the study involved establishing the congruence of BMI, BIA and skin fold calipers in assessing body composition of children aged between 10 and 15 years. It was also in the second phase that an experiment was conducted to establish the effects of a 10 weeks aerobic dance exercise program on body composition of these children. Therefore, a classic experimental design was used in this phase of the study. The design consists of two comparable groups: an experimental group and a control group (Thomas, Nelson and Silverman 2005). Pre-test was taken for both groups prior to the introduction of aerobic dance exercises to the experimental group. Post-test was conducted on both groups after 10 weeks of exposing the experimental group to aerobic dance exercises. This was done to enable comparisons and further hypotheses testing.

3.3 Research variables

The independent variables for this study were age, gender and type of school (i.e private or public). As explained by Vincent (1995), Nachmias and Nachmias (1996), and Mugenda and Mugenda (2003), these variables are totally free to vary by themselves and do not co-vary with other variables. The dependent variables for this study were body mass index (BMI) and percent body fat measured by BIA and skin fold calipers. Changes in these variables are presumed to be influenced by treatment and the independent variables (Nachmias and Nachmias, 1996).

3.4 Location of the study

The study was conducted in private and public primary schools in Nairobi province. This location was chosen for the study since within the province, children are exposed to modern lifestyle that includes facilitated transport, availability of fast foods stocked in virtually all shops and supermarkets as well as availability of videos television and computer games as explained by Wikipendia (2008). This leaves very little or no time for physical activity hence predisposing children to the pandemic of overweight and obesity.

3.5 Target population

The target population comprised children aged between 10 to 15 years in Public and Private Primary schools in Nairobi province. There were about 6400 pupils aged between 10 and 15 years in private schools and about 47,150 pupils of the same age group in public schools (Nairobi city Education Office 2006). The target population for this age group was approximately 53,550.

3.6 Sample size and sampling procedure

A multi-stage sampling procedure was used in the study for preliminary sampling of educational divisions. According to Francis (1998), this procedure involves splitting the area up into a number of regions and then randomly selecting a small number of the regions. The study therefore involved splitting of public and private primary schools in Nairobi Province according to their respective divisions. Each division acted as a region.

There are eight divisions in Nairobi province. Four divisions were randomly selected as a basis for providing a sample for the study. From the four divisions, convenience sampling procedure was employed to select the 24 public schools (n=3846) and 5 private schools (n=1479) that participated in the study. According to Singleton, Straits and Straits (1993), convenience sampling involves selecting a requisite number from cases that are conveniently available. The researcher only used schools where permission was granted by the school administration. There were fewer private schools than public schools available for the study because most private schools have policies that prohibit the use of pupils for research purposes. All class five; six, seven and eight pupils in the sampled schools participated in the first phase of the study hence providing a sample of 5325 pupils.

Two schools where pupils showed high incidences of overweight and obesity were purposively selected for the second phase of the study that involved treatment with aerobic dance exercises for a period of 10 weeks. The total number of pupils in this phase was 69, comprising 48 pupils in the experimental group and 21 pupils in the control group. Before treatment, the pupils were taken through a more comprehensive phase of tests, which included overweight and obesity assessment using BMI, BIA system and skin fold measures. Post-test measurements were conducted during the 11th and the 12th week to establish changes if any in the above variables.

3.7 Instrumentation

Overweight and obesity status of the pupils was determined using BMI, BIA system and skin fold skin fold calipers. Since weight and height are required in calculating BMI and the BIA based percent body fat, anthropometric measures were determined in accordance to the recommendations by the International Society for Advancement of Kinanthropometry in 2001 as follows:

3.7.1 Weight

Body weight was determined using the Health Ometer large floor dial bathroom scale (Long bang machinery co., China) to the nearest 0.5killograms. The pupils stood on the scale barefooted and wearing only their school physical education uniform since weight could be affected by heavy clothing. They were advised to exhibit minimal or no movements with their hands by their side and their head erect. To improve reliability, their weight was taken in the morning just before their tea break and immediately after they had emptied their bladders. This was because the body's hydration level usually affects weight.

3.7.2 Height

Height was measured to the nearest 0.5 centimeter then converted to meters by dividing the values by 100 using GW-556 measuring tape (The perfect measuring tape Co., USA) that was validated using a standiometer. A validity index of 0.96 was obtained after the two measures were correlated using Pearson moment product correlation. The pupils stood against the wall barefooted with their feet parallel to each other, head erect and the heels, buttocks and shoulders touching the wall. They stepped on the steel edge of the measuring tape from the side of the foot maintaining it on the floor. The tester held the chin of the pupil up to ensure that the position of the chin appeared perpendicular to the measuring tape. The tape was then extended from the side up to the topmost part of the pupil's head and the length reading taken and recorded on the protocol sheet.

The resulting weight and height scores were then used in calculating BMI and BIA percent body fat scores as follows:

3.7.3 BMI

BMI is and index that is obtained from weight in kilograms divided by the square of height in meters (kg/m^2). Upon calculating the BMI score, the score was plotted on the WHO BMI –for –age growth charts of 2007 for either girls or boys to obtain a percentile ranking. WHO (2007) BMI-for-age growth tables for girls and boys are shown in appendices F and G respectively. Weight status categories for the calculated BMI-for-age percentiles were then determined using the graphs in appendices H and I for girls and Boys respectively. The standards for weight status categories were presented in chapter two on Table 2.1.

3.7.4 BIA percent fat

Prior to the leg-to-leg BIA assessment of percent body fat, pupils removed their shoes and socks. Height was assessed using measuring tape 5m by 19m GW-556E model. Height was measured to the nearest 0.5 centimeters. Pupils' height was then entered into the BIA system (Tanita TBF-521 model) with the height setting dial and the appropriate gender option selected using the gender button. The child mode was used for all assessments. The pupils waited till the display showed 0.0 and then they were instructed to stand with their legs straight, feet parallel with the heel and forefoot placed on the metal plates of the le-to-leg BIA system. A sub threshold electrical current was then transmitted through the body from leg-to-leg. Body weight and an impedance based percent fat value was indicated on the screen of the BIA system. The percent value was used as the percent body fat value measured by the BIA system.

3.7.5 Skin folds percent fat

Skin fold measures were taken on the right side of the subjects while standing using the range skin fold calipers as per the protocol provided by the International Society for Advancement of Kinanthropometry (2001). At the appropriate site, a fold of the skin was grasped using the thumb and the forefinger of the tester's left hand as suggested by Gatchell et al. (1998) and three measures taken on each site. The tester pinched the skin to raise a double layer of skin and the underlying adipose tissue but not the muscles. The calipers were then applied 1 centimeter (cm) below and at right angles to the pinch and a reading in millimeters (mm) taken 2 seconds later. For females, the skin folds were taken from the triceps, suprailium and thighs where as for the males, the folds were taken from the chest, abdominal and thighs as shown in appendix A. An average of the three measures from each site was computed. The sum of the average of the skin fold measures from the three sites was then determined and used in the density equations shown in appendix B for girls and appendix C for boys. The siri equation for determining percent body fat in children (530/ Density - 489) was used to compute for percent body fat of the pupils using the calculated body density values. The calculated percent body fat value was then recorded in the protocol sheet.

3.8 Pilot test

The research instruments, BMI, BIA and skin fold calipers were piloted in Moi Avenue and Horizon Academy primary schools. This was done to give the researcher and the eight research assistants exposure in terms of taking correct measures of BMI, BIA and skin fold as well as establishing the administrability of the test to the subjects. It was also aimed at orienting the ten research assistants to the treatment procedures of administering the aerobic dance exercises correctly. The reliability of the research instruments was also determined using the pilot test data.

3.8.1 Reliability

Reliability is a measure of the degree to which are search instrument yields consistent results or data after repeated trials (Mugenda and Mugenda, 2003). In the current study, reliability was determined using the test-retest method at a week's interval, which involved administering the same instrument twice to the same group of the pupils in Moi Avenue and Horizon Academy primary schools. According to Mugenda and Mugenda (2003), the appropriate time lapse between the first and the second test in this method should be between one to four weeks.

The weights determined using health Ometer 142kl large dial bathroom scales yielded a correlation coefficient of 0.88. The heights determined using GW-566 measuring tape yielded a correlation coefficient of 0.95. BIA system yielded a correlation coefficient of 0.85 while skin fold calipers yielded a correlation coefficient of 0.81. All these coefficients were significant at p<. 05 level. According to Mugenda and Mugenda, (2003), a coefficient of 0.80 or more implies that there is a high degree of reliability of the data. Therefore, the high coefficients obtained during the pilot test implied that there was an acceptably high degree of reliability of the research instruments that were used in the study.

3.9 Data collection procedure

Data for the first phase of the study that involved establishing the general prevalence of overweight and obesity amongst children aged 10 to 15 years in Nairobi province Kenya was obtained during the first term of year 2006 using BMI. This involved measuring the pupils' weight and height by the researcher and the research assistants. Body weight and height were recorded in the protocol sheet and BMI calculated using the formula weight (kg)/height (m^2). The BMI scores were then plotted on the age and sex specific WHO (2007) growth charts to obtain percentile ranks. Pupils whose BMI scores were above the 85th percentile were put on more test procedures by BIA and skin fold techniques.

During the second term of year 2006, two schools where pupils were confirmed to be either overweight or obese following assessment using skin fold and BIA techniques in the first week were purposively selected to offer the experimental and control groups. Where as the control group was not taken through any mode of exercise, the experimental group was taken through a low impact aerobic dance program for a period of ten weeks. These pupils were required to be in their physical education uniforms. The school administrators preferred gospel music for the aerobic programme. The gospel music that was initially pitched at 120 beats per minute, which is the lowest, recommended level for low impact aerobics (Bishop, 1999).

According to Gelder and Marks (1987), this kind of aerobic dance exercises is designed to provide an aerobic experience without the risk of injury that may result from the stress of high impact movements. To accomplish this recommendation, the fitness instructors who were hired from the Kenyatta University Gymnasium and the researcher ensured that one foot of the pupils was always in touch with the floor at all times. They also ensured that there were no jumping movements by substituting them with movements that lowered and then raised the pupils' centre of gravity. After the third week, the pupils' in the experimental group were put on an increased intensity of the program where the music was pitched at 132 beats per minute.

As the pupils progressed into the programme, the intensity was gradually increased to 140 beats per minute at the seventh week, which is the highest level for low impact aerobic exercises that allow sufficient time to execute large movements. Additionally, the intensity to raise their heart rate was further increased by ensuring that the pupils executed large controlled arm movements. Gelder and Marks (1987) indicate that large moving patterns are effective for raising the heart rate. The aerobic sessions were conducted in the field usually after the other lessons were over. The sessions lasted for one hour(10minutes warm up, 40 minutes energy burst and 10 minutes stretching and cool-down) as recommended by Moran and Arizona (1999). The pupils were encouraged to take enough water before, during and after the lessons to avoid being dehydrated.

A posttest using BMI, BIA and skin fold techniques was administered at the 11th week of second term. Information obtained both from pretest and posttest was recorded in the protocol sheets as shown in appendices D and E.

3.10 Data analyses and presentation

The study aimed at assessing the prevalence of overweight and obesity among children aged 10 and 15 years in public and private primary schools in Nairobi province, Kenya. It was also the aim of the study to establish the congruence of BMI, BIA and skin fold calipers in estimating body composition of these children. The study further aimed at determining the effects of a 10 weeks aerobic dance exercise program on body composition of these children. The variables of the study included, gender, type of school and age. The study analysed how these variables influence body composition of children aged 10 to 15 years. Data obtained from the study were coded and entered into the computer. They were subsequently subjected to statistical analysis using the Statistical Package for Social Sciences (SPSS) version 12. The results of the analysis were presented in tables. Descriptive statistics, (i.e. mean, percentages and standard deviation) were used to summarise the raw data. Percentile ranks were also used to interpret BMI raw scores for age and gender.

3.10.1 Independent samples t-tests

According to Vincent (1995) independent samples t-test is conducted to compare means of subjects who are in one sample and are not related or correlated in any way to the subjects in the other sample. Given the unrelatedness of gender in terms of males and females and type of school in terms of public and private, independent samples t test were used to determine the effect of gender and type of school on BMI mean scores.

3.10.2 Dependent samples t-tests

According to Vincent (1995), dependent samples t-test is used to compare means of subjects who have been tested twice such as in pre-post comparisons. Vincent (1995) adds that dependent samples assume that there is a relationship or correlation between the scores and that a person's score on the post-test is partially dependent on his or her pre-test score. In this study, the pupils in the experimental group were given pre-test, subsequently treated with aerobic dance for 10 weeks and then given a post-test. Dependent samples t-tests were therefore used in the study to compare the pre-test and the post-test means on BMI, BIA and skin fold measures in order to determine the effects of treatment with aerobic dance exercises on body composition.

3.10.3 Analysis of variance

Analysis of Variance (ANOVA) is a parametric statistical technique used to determine whether significant differences exist among means of three or more sets of data (Vincent, 1995). One-way ANOVA is applicable where there is only one independent variable that is measured at either nominal or ordinal levels (Hinton, 1995). In this study, one-way analysis of variance was used to determine the effects of different age groups on BMI, BIA and skin fold mean scores. Research hypotheses were tested at 0.05 alpha levels. Post hoc analysis was conducted using the Tukey HSD test to locate inter-group differences at 0.05 alpha level upon obtaining significant F values as explained by Vincent (1995).

3.10.4 Pearson product moment correlation

It is a numerical coefficient that indicates the extent to which two variables are related or associated and the coefficient is always between +1.00 and -1.00 (Vincent, 1995). Pearson product moment correlation was used to show the relatedness between BMI and BIA, BMI and skin fold calipers and BIA and skin fold calipers in assessing body composition.

3.11 Logistical and ethical considerations

To start up the study, the researcher obtained a research permit from the Ministry of Education, Science and Technology. The researcher also obtained a research authority from the City Education office of Nairobi Province alongside a letter of introduction to schools within Nairobi province. The process also involved acquiring consent letters from the school head teachers of the schools that were used in the study. The process also involved the identification whereby the researcher and the research assistants introduced themselves to the participants. This was always done in company of the physical education teachers for the various schools and classes. The researcher sensitized the pupils on the purpose of the research, as well as encouraging them to continue in the testing process. This was especially important for the pupils in the experimental group since they had to keep up into the activities until 10 weeks were over.

During the research, the researcher and the research assistants avoided mentioning of the pupils' weight to the rest of the participants. This was for confidentiality purposes and to avoid stigma and probably pulling out by the overweight and obese subjects. Since overweight and obesity is a sensitive area of study, the researcher did not disclose the names of the pupils or the schools where the study was conducted. The researcher had female participants assessed by female research assistants while male participants were assessed by male research assistants especially when taking the skin fold measures.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The purpose of this study was to establish the prevalence of overweight and obesity among primary school children in Nairobi province, Kenya. Overweight and obesity were tested using BMI against age, gender and type of school. The study also purposed to establish if BMI correlated significantly with other body composition assessment procedures, which included skin, fold measures and BIA system. It was also the purpose of the study to establish the effects of a 10 weeks aerobic dance exercise program on body composition among children in the upper primary school age.

To achieve these goals, the following research objectives were formulated and used as a guide to the study.

i. To asses the prevalence of overweight and obesity using BMI amongst children aged between 10-15 years in private and public primary schools in Nairobi province, Kenya.

ii. To establish the most susceptible group to overweight and obesity between male subjects and female subjects aged between 10-15 years.

iii. To establish if there were any differences in overweight and obesity between children in private primary schools and those in public primary schools.

iv. To establish if there was any congruence amongst BMI, BIA and skin fold measures in assessing body composition of primary school children aged 10-15 years.

v. To assess the effects of a 10 weeks aerobic dance exercise program on body composition of overweight and obese children aged 10-15 years.

In order to guide the attainment of the above objectives, hypotheses were formulated and tested by use of independent samples t- test, paired samples t-test, Pearson moment product correlation and one way analysis of variance (ANOVA). To test the strength of the resulting significant differences from ANOVA, Tukey HSD was used. All hypotheses were either accepted or rejected at $p < .05$ alpha level.

Additionally, the findings of the study were presented, interpreted and discussed as follows.

4.2 Presentation of findings of the study

In this section, the findings of the study are presented and analysed.

4.2.1 Demographic information of the pupils who participated in the study

This section describes the demographic characteristics of the pupils who took part in the study. These characteristics formed the independent variables (age, gender and type of school) and are presented in Table 4.1.

Table 4.1 Demographic characteristics of the pupils.

Age	Gender		Type of school	
	Male	Female	Private	Public
10	118	179	188	109
11	341	462	353	450
12	660	723	433	950
13	717	735	370	1082
14	523	420	129	814
15	261	186	6	441
Total	2620	2705	1479	3846

Table 4.1 shows that the pupils involved in the study had their age range between 10 to 15 years. These pupils were in upper primary classes (standard 5 to 8) and were either at the onset of adolescence growth spurt or in the adolescent period proper. This period is characterized with increased autonomy, which is often associated with irregular meals, changed food habits and periods of psychological changes which promote increased fat deposition particularly in females (WHO, 1998). This age group therefore offered an appropriate population for the study since it is one of the periods in life when body fat increases hence predisposing individuals to overweight and obesity later in life. Again it is possible to identify body fatness in this period and offer remedies early enough to prevent obesity and its related health problems in adulthood.

4.2.2 Demographic Characteristics of pupils by gender

The subjects of the study included 2620 (49.2) % males and 2705 (50.8%) female pupils as shown in Figure 4.1.

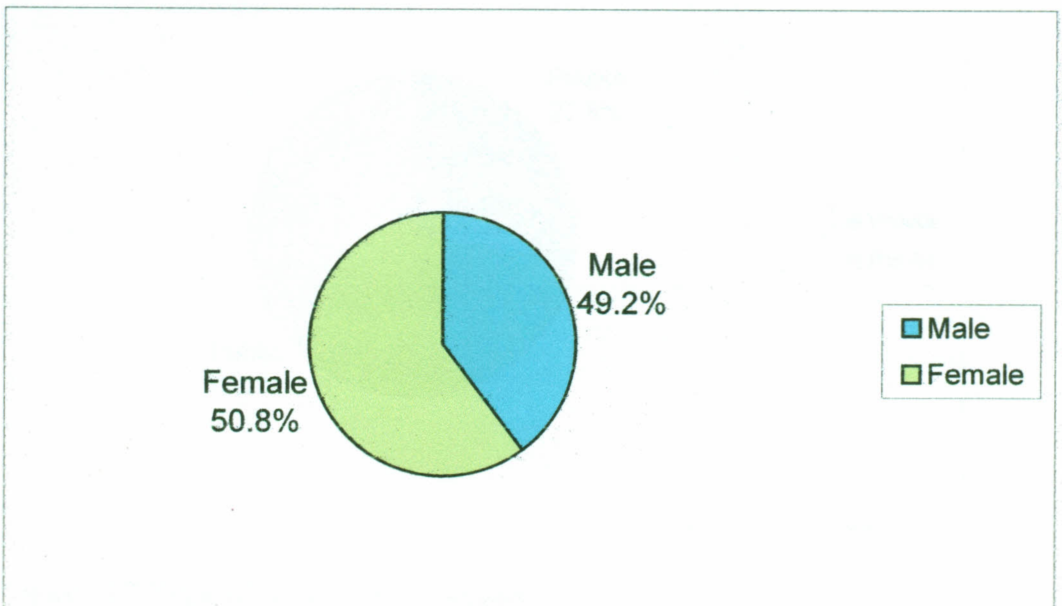

Figure 4.1: Gender of the pupils

The percentages in Figure 4.1 show that there were slightly more female pupils aged 10-15 years than male pupils of the same age in schools that participated in the study. This is true because in attempt to explain the increased number of female pupils than the male pupils in the Kenya primary schools, the UK Department of International Development (2007) indicate that the changing parental and community attitudes has caused the dramatic improvement in access to schooling opportunities to the girl child. The UK Department for International Development (2007) further notes that the presence of the same sex- adult role models in the school as well as the girls needs being given more attention has also increased the population of girls in primary schools.

4.2.3 Demographic characteristics of pupils by type of school

Figure 4.2 shows the proportion of pupils from private and public primary schools who participated in the study.

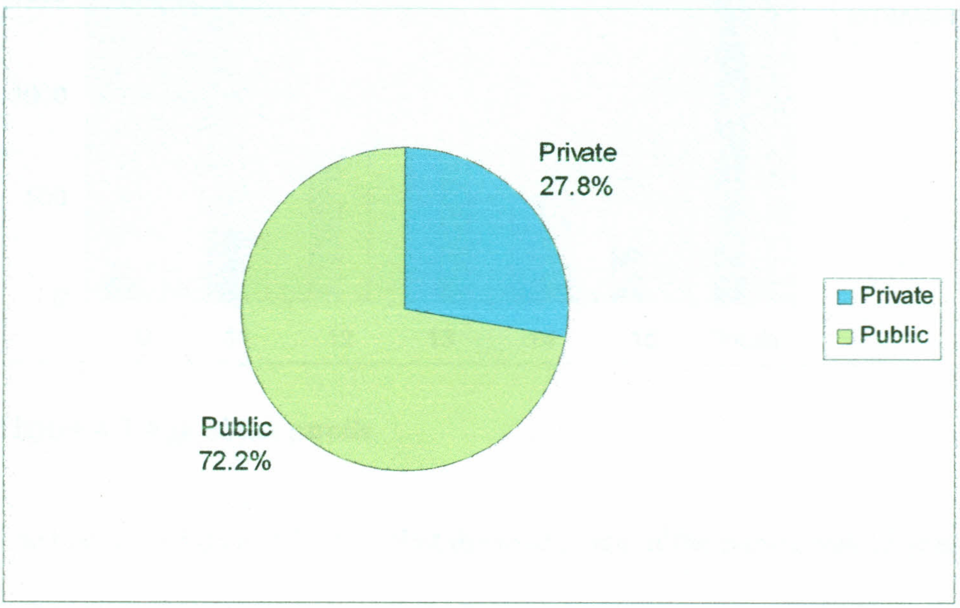

Figure 4.2 Type of school of the pupils

The percentages of the participants as indicated in Figure 4.2 show that majority of the pupils who took part in the study were selected from public schools. This was due to the fact that there are fewer pupils enrolled in private primary school compared to those enrolled in public primary schools in Kenya. Furthermore, accessing participants from private primary schools was difficult for this study than in public primary schools.

4.2.4 Demographic characteristics of the pupils by age

The ages of the pupils who took part in the study are as shown in Figure 4.3.

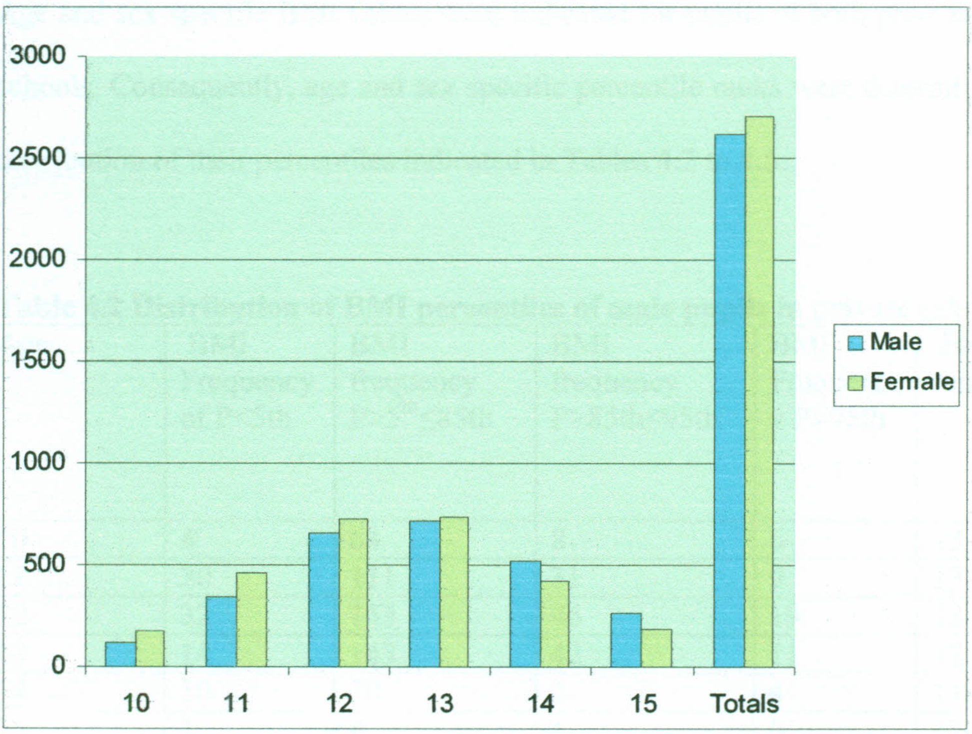

Figure 4.3 Age of the pupils

The results in Figure 4.3 show that the modal age of the pupils was 13 years. This means that majority of the pupils in the upper primary were aged 13 years for both boys and girls. This is the period when majority of the girls are at the peak of the adolescence growth spurt while the boys are at the beginning of the adolescence growth spurt (Gormly & Brodzinsky 1990).

Therefore, it was important to further look into the distribution in order to find out if these differences in age sex and type of school had any implications for the BMI scores of the pupils.

4.2.5 Age and gender specific BMI percentiles of the pupils in private and public primary schools

Age and sex specific BMI values were indicated for pupils in both private and public schools. Consequently, age and sex specific percentile ranks were determined and the distribution of their percentiles indicated in Tables 4.2 to 4.5.

Table 4.2 Distribution of BMI percentiles of male pupils in private schools

Age	BMI Frequency of P<5th	BMI frequency P>5th≤85th	BMI frequency P>85th≤95th	BMI Frequency P>95th	BMI range	Total
10	4	64	8	6	13-27	82
11	20	111	31	9	13-30	171
12	32	153	46	19	12-31	250
13	14	143	42	11	12-36	210
14	10	70	2	4	11-31	86
15	1	4	1	0	17-24	6
Total	81	545	130	49		805
Percentage	10.1%	67.7%	16.1%	6.1%		100%

Table 4.2 shows that 805 male pupils aged between 10-15 years from private primary schools participated in the study. Their BMI scores ranged differently for various age groups as indicated by the percentages in Figure 4.4, with age 15 recording the narrowest range (17-24) and age 13 recording the widest range (12-36).

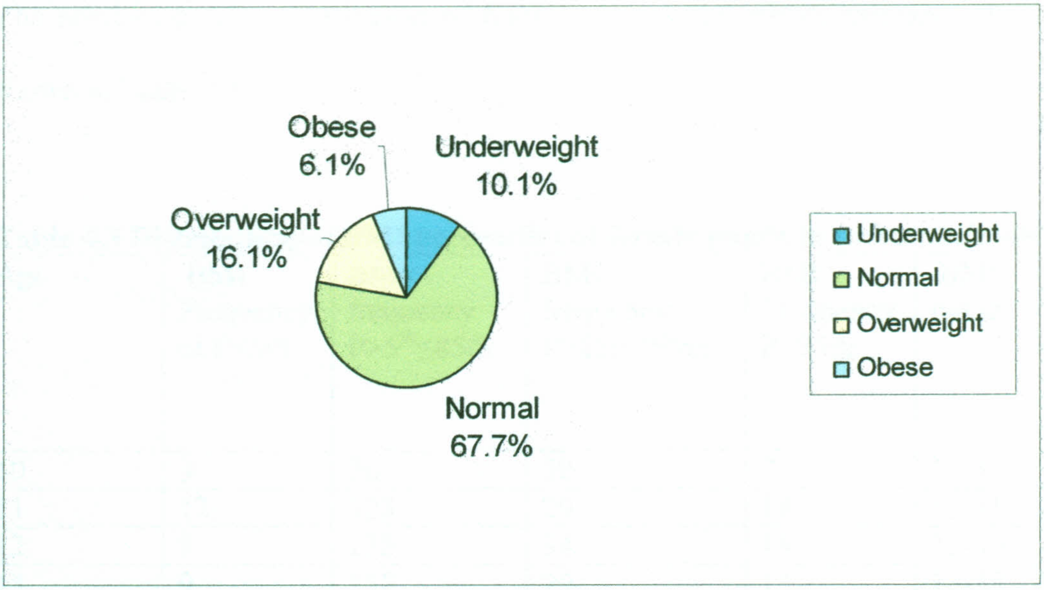

Figure 4.4 Percentages distribution of BMI percentiles of males in private schools

From Figure 4.4, it is evident that there are overweight and obese male children in private schools in Nairobi as per the WHO (2007) percentile cut off points for BMI. The results also show that whereas the bigger percentage (67.7%) of the male pupils in private schools had BMI scores that fell within the normal range as per the WHO (2007) percentile cut off points (between the 5th and the 85th percentiles), 16.1% were overweight (between 86th and 95th percentiles), 6.1% were obese (above 95th percentile) and 10.1% were underweight. According to these results, although majority of the pupils in private primary schools in Nairobi province have normal body weight, there is a reasonable percentage of the pupils who are overweight and obese. These percentages of overweight (16.1%) and obese (6.1%) pupils are comparable to those in most developed countries such as in the US where 25% of children are overweight and 11 % obese (Dehghan, Aktar-Danesh and Merchant 2005).

The results on BMI distribution of female subjects in private primary schools are shown in Table 4.3.

Table 4.3 Distribution of BMI percentiles of female pupils in private schools

Age	BMI Frequency of P<5th	BMI frequency P>5th≤85th	BMI frequency P>85th≤95th	BMI Frequency P>95th	BMI range	Total
10	3	76	20	7	13-37	106
11	12	123	29	18	13-31	182
12	8	128	34	13	12-30	183
13	9	118	20	13	13-38	160
14	1	27	12	3	25-30	43
Total	33	472	115	54		674
Percentage	4.9%	70.0%	17.1%	8.0%		100%

Table 4.3 shows that 674 female pupils aged between 10-14 years in private schools participated in the study. The distribution of BMI scores in Table 4.3 shows that there were overweight and obese female children in private primary schools in Nairobi province as per the WHO (2007), BMI percentile cut off points as shown in Figure 4.5.

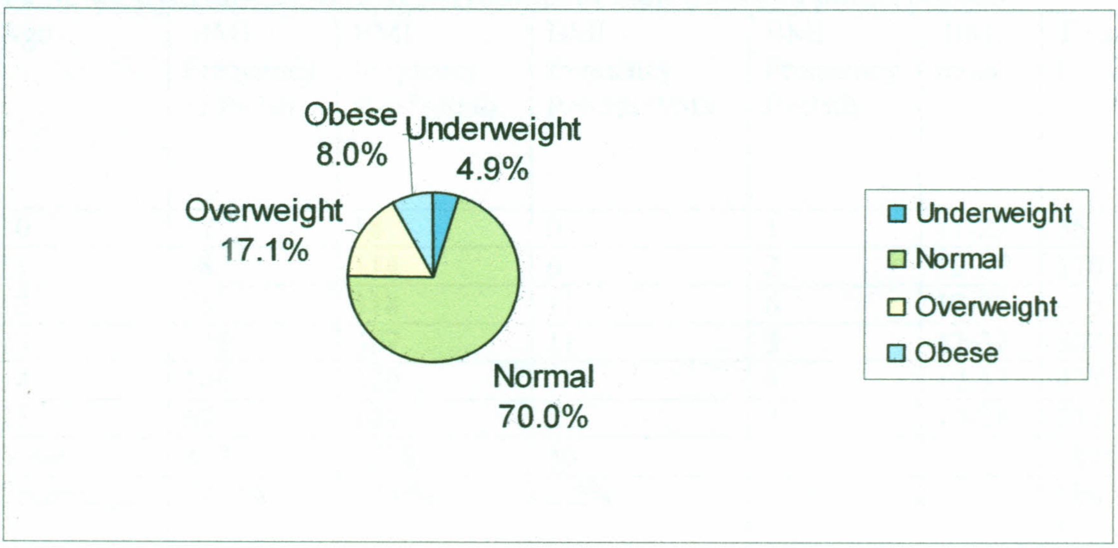

Figure 4.5 Percentages distribution of BMI values of females in private schools.

The results in Figure 4.5 show that 54 female pupils (8.0%) had BMI scores above the 96th percentile hence obese, while 115 (17.1%) had BMI between the 86th and 95th percentiles hence overweight. The results further indicate that 472 female pupils (70.0%) had normal BMI scores (between the 5th and 85th percentiles) while 33 (4.9%) were underweight with their BMI score below the 5th percentile. These results are a clear indication that majority of female pupils in private primary schools in Nairobi province have normal body weight. However, there are cases of overweight and obesity that should be given attention in terms of providing them with management strategies so as to prevent these conditions from tracking into adulthood. These results are similar to the previously observed results in the male pupils in private schools.

The distribution of BMI scores of male pupils in public primary schools are presented in Table 4.4.

Table 4.4 Distribution of BMI percentiles of male pupils in public schools

Age	BMI Frequency of P<5th	BMI frequency P>5th≤85th	BMI frequency P>85th≤95th	BMI Frequency P>95th	BMI range	Total
10	17	18	0	1	11-27	36
11	48	114	6	2	12-30	170
12	75	318	11	6	12-32	410
13	126	367	11	3	12-32	507
14	106	320	7	4	12-32	437
15	67	181	5	2	13-28	255
Total	439	1318	40	18		1815
Percentage	24.2%	72.6%	2.2%	1.0%		100 %

Table 4.4 shows that 1815 male pupils aged 10-15 years in public schools took part in the study. The percentage distribution of these BMI values is further shown in Figure 4.6.

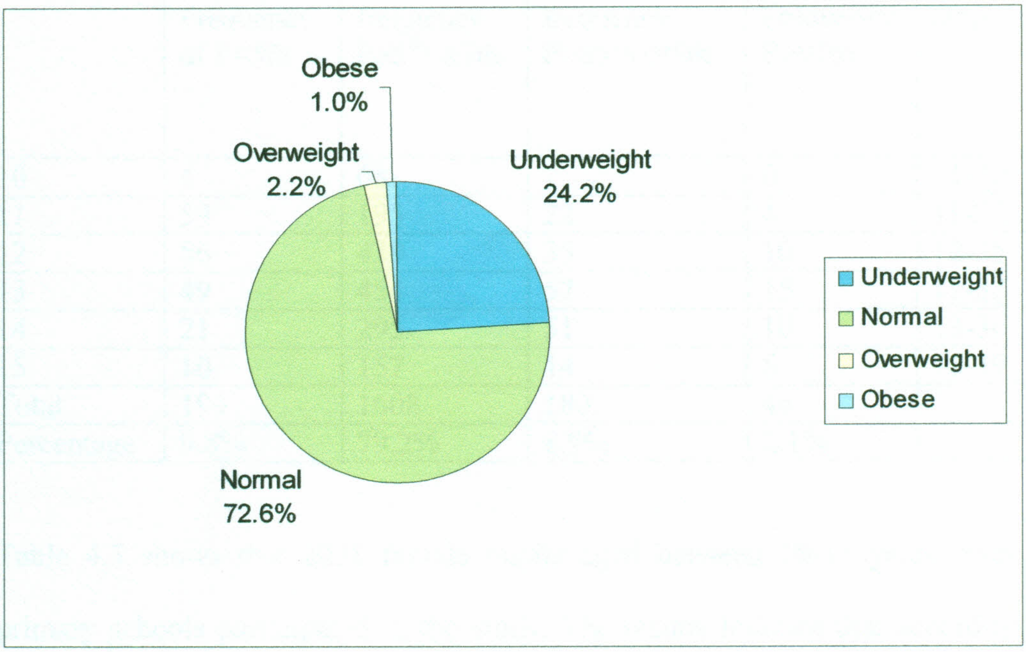

Figure 4.6 Percentages distribution of BMI values of males in public schools

The results show that 18 pupils (1.0%) were obese (with BMI scores above the 96th percentile) and 40 (2.2%) were overweight (with BMI scores between the 86th and 95th percentiles). The results further indicate that majority of the pupils (1318, 72.6%) were of normal weight (with BMI scores between the 5th and 85th percentiles) and 439 (24.2%) were underweight (with BMI scores below the 5th percentile). Again, these results indicate that although majority of male pupils in public primary schools in Nairobi province have normal body weight there are cases of overweight (2.2%) and obesity (1.0%). The percentages are however not as greater as in private schools. Instead, there are more cases of underweight (24.2%) in public primary schools than in private primary schools.

The distribution of BMI sores of females in public primary schools age 10-15 years are shown in Table 4.5.

Table 4.5 Distribution of BMI percentiles of female pupils in public school

Age	BMI Frequency of P<5th	BMI frequency P>5th≤85th	BMI frequency P>85th≤95th	BMI Frequency P>95th	BMI range	total
10	4	68	1	0	11-22	73
11	59	195	22	4	11-27	280
12	56	439	35	10	12-35	540
13	49	454	57	15	12-32	575
14	21	295	51	10	13-36	377
15	10	157	14	5	13-39	186
Total	199	1608	180	44		2031
Percentage	9.8%	79.2%	8.9%	2.1%		100%

Table 4.5 shows that 2031 female pupils aged between 10-15 years from public primary schools participated in the study. The results indicate that according to the WHO (2007) percentile rank cut off points for children's BMI, there were cases of overweight and obesity amongst this group. The percentage distribution of their BMI values is as shown in Figure 4.7.

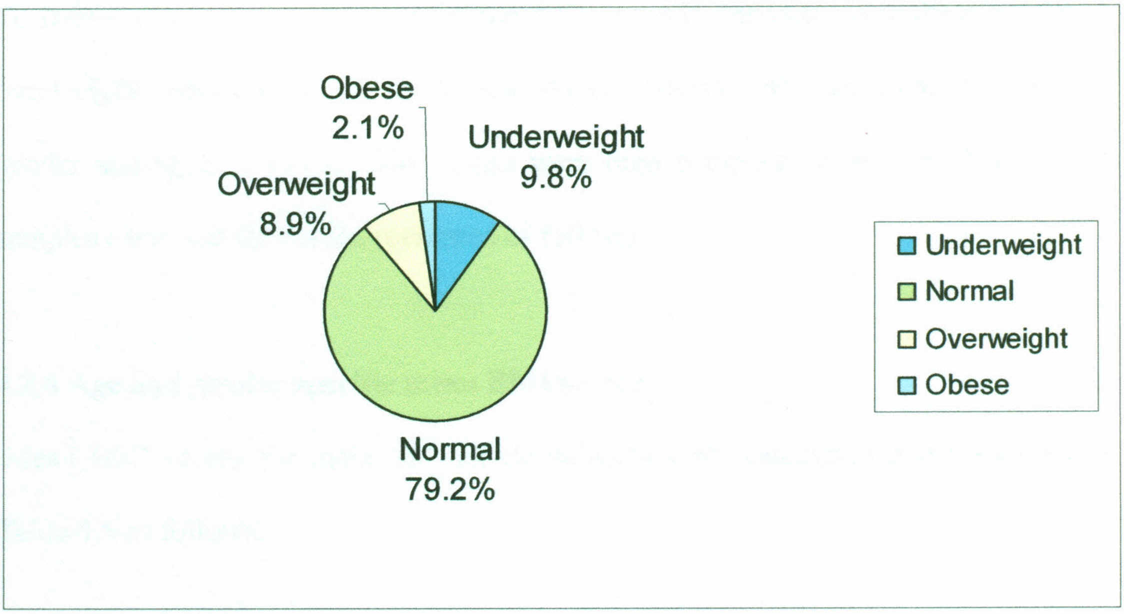

Figure 4.7 Percentages distribution of BMI values of females in public primary schools.

According to Figure 4.7, 44 female pupils (2.1%) had their BMI scores falling above the 95th percentile hence obese, while 180 pupils (8.9%) were overweight (with BMI scores between the 86th and 95th percentiles). Majority of the pupils (1608, 79.2%) had normal BMI scores (with BMI scores between the 5th an 85th percentiles) and 199 pupils (9.8%) were underweight (with BMI scores below the 5th percentile). These results imply that although majority of primary school pupils in Nairobi province have normal body weight, there are cases of overweight and obesity. However, the percentages of female pupils who are overweight and obese in public primary schools are smaller than those of the female pupils in private primary schools. Additionally, the results show that there cases of underweight in which case the percentage of underweight pupils is greater in public primary school than in private primary schools.

To farther assess the implications of the differences in percentages in the numbers of overweight and obese pupils, means and standard deviations were computed for age, gender and type of school. The means were then compared using the independent samples t-test and the results presented as follows.

4.2.6 Age and gender specific mean BMI scores

Mean BMI scores for male and female subjects were calculated and presented in Table 4.6 as follows:

Table 4.6 Means, standard deviations and independent t values of BMI scores by gender

Gender	n	$\overline{X}$	SD	t	df	sig
Male	2620	17.33	2.81	16.82	5323	0.000
Female	2705	18.76	3.38			
Total	5325					

$t(5323)=1.960, p<.05$

Table 4.6 shows that female pupils recorded high mean BMI and standard deviation scores ($\overline{X}$ 18.76±3.38) than their male counterparts who recorded mean BMI score and a standard deviation of ($\overline{X}$=17.33± 2.8). These results indicate that probably female pupils have greater BMI scores than their male counterparts. To establish if the difference in mean BMI scores between girls and boys was statistically significant, independent samples t-test was conducted and the results are as shown in Table 4.6. The results in Table 4.6 were $t(5323)=16.82$, $p<.05$, indicating that there was a significant difference in mean BMI scores between boys and girls. This confirmed that there was a significant difference in BMI scores of boys and girls in Nairobi province, Kenya. This difference could be attributed to the fact that females tend to have higher percent body fat than their male counter parts especially during adolescence. Franks and Howley (1997) attribute this difference in percent body fat between males and females to the childbearing functions of the females. Wilmore and Costil (1999), in support of the finding that there are significant differences in BMI scores between males and females noted that at puberty, the body composition of the sexes begins to differ markedly primarily because of the endocrine changes. Additionally, WHO (1998) in accounting for the differences in BMI of males and females indicate that there are a number of physiological processes that contribute to an increased storage of fats in females. According to WHO (1998), such deposits are essential in ensuring female reproductive capacity.

These results are similar to those observed by Underhay et al. (2005) and Bunkoff and Moutinho (2004), who in separate studies observed that females tend to have higher mean percentage body fat than males. Underhay et al. (2005) conducted a cross-sectional study on 605 males and 640 females aged between 10 to 15 years from different ethnic backgrounds in South Africa. Although the major aim of the study was to assess prevalence of obesity and high blood pressure in relation to ethnicity, the authors also observed that females have higher percent body fat than their male counterparts. The results of this study also concur with the findings by Rao et al. (2008), who observed that mean percent body fat and BMI were significantly ($p<.01$) higher in girls than boys beyond 13 years. In their study, Rao et al.(2008) also observed that mean Total Skin fold Thickness (TSFT) and percent body fat for girls was higher than of boys in every age group but differences widened beyond 13 years age.

The distribution of mean BMI scores, standard deviations and independent t-test by gender and type of school was conducted and the results indicated in Table 4.7.

Table 4.7 Means, standard deviations and independent t-values of BMI scores by gender and type of school

School	Gender	N	$\overline{X}$	SD	t	df	sig
Private	Male	805	18.30	3.40	6.87	1477	.000
	Female	674	19.61	3.85			
Public	Male	1815	16.90	2.40	17.55	3844	.000
	Female	2031	18.48	3.19			

Table 4.7 shows that, females in each school category (private $\overline{X}$=19.61 and public $\overline{X}$=18.48) recorded higher mean BMI scores than the male pupils who recorded mean BMI scores ($\overline{X}$=18.30 and ($\overline{X}$=16.90) respectively. The greater BMI mean scores of the females are attributed to their having greater amount of percent body fat than the male counterparts This showed that irrespective of school category, females always tend to exhibit greater percent body fat which translates to the greater BMI scores than their male counterparts. Similarly, independent t-tests were conducted for gender when each type of school was considered as a separate entity (either private or public) and the results also indicated in Table 4.7. The results in Table 4.7 were t (1477) = 6.87, p<. 05 indicating that actually there was a significant difference in mean BMI scores between male and female pupils in private schools. Similarly the table also shows that t (3844) =17.55, p<. 05 indicating that the difference in mean BMI scores of male and female pupils in public schools were statistically significant.

From the results it was observed that there are significant differences in BMI scores between males and females with the females having greater BMI scores than their male counterparts irrespective of their school category. This observation can be explained by the fact that, subjects were drawn from pre-pubescent and pubescent stages of human growth and development. According to Bonnet and RocourBrumioul (1981), the second spurt in human development occurs at this stage with the result of greater fat mass in girls than in boys. Wilmore and Costil (1999) also further support theses findings in their observation that major differences in body size and composition between girls and boys do not start to appear until puberty. Wilmore and Costil (1999) further indicate that at puberty, the body composition of the sexes begins to differ markedly primarily because of endocrine changes. Additionally, the results agree with those of Rowland (1996) who observed that on average, the young but mature female adolescent can have a body fat content 50% greater than that of her male counterpart of the same age.

Mean BMI scores were also assessed in terms of the type of school where the subjects of the study were drawn from and the results presented in Table 4.8.

Table 4.8 Means, standard deviations and independent t-values of BMI scores by type of school

School type	n	$\overline{X}$	sd	t	df	sig
private	1479	18.89	3.67	10.87	5323	.000
public	3846	17.73	2.95			
total	5325					

Table 4.8 indicates that, pupils in private schools recorded higher mean BMI score of $\overline{X}$=18.89±3.67 than their counterparts in public schools who recorded a mean BMI score of $\overline{X}$=17.73±2.95. These results evidently indicated that probably pupils in private schools were more susceptible to overweight and obesity than their counterparts in public schools. To test if the difference in the BMI means of pupils in private schools and pupils in public schools was significant, an independent t-test was conducted and the results shown in Table 4.8. The results were, $t (5323) = 10.87$, $p<.05$ indicating that the difference in the means was significant. The significant

difference in BMI between pupils in private schools and pupils in public schools could be attributed to the fact that most of the pupils who enroll in private schools come from well to do families. These are families which have adopted modern lifestyle whereby children are dropped daily at school, and have readily available snacks and most of their time is spent more on learning than doing physical activities hence predisposing them to overweight and obesity.

According to Okwach and Odipo (1997), pupils in private primary schools in Kenya enjoy more learning time than those in public primary schools. Okwach and Odipo (1997) further observe that there are extra tuition activities in private schools than in public schools hence leaving little time for engaging in physical activity. Additionally, pupils in private schools tend to come from families with a modern lifestyle and more resources hence the predisposition towards overweight and obesity.

Conversely, most pupils enrolled in public primary schools come from low social economic backgrounds, which do not favour the occurrence of overweight and obesity. Although there were cases of overweight and obesity in these schools, the percentages were not as high as in the private schools. This could be explained by the fact that most parents cannot afford a lifestyle that predisposes children to overweight and obesity in terms of feeding. In fact from the results majority of the underweight cases are from the public primary schools. Again most of these pupils walk to school since they attend schools that are near their vicinity and once in the school they do most of the cleaning of their classes. According to Okwach and Odipo (1997), pupils in public schools are involved in the morning cleaning exercise and since they do not conduct extra tuition activities, their co -curriculum activities and physical education lessons are not largely affected.

These results concur with those by Bogin and Sullivan (2005), who observed that there are significant differences between groups with those belonging to lower social economic status having less fat than the higher social economic status groups. The results are partly similar to those observed by Moreno et al. (2005), who from their study observed that the prevalence of overweight and obesity varied significantly with social economic status amongst boys only. The results showed that boys from high social economic status showed more prevalence of overweight and obesity than boys from low social economic status. From the current study however, the differences in prevalence of overweight and obesity between pupils from private primary schools and pupils in public primary schools, which helped in categorizing social economic status, exists irrespective of sex. This is to mean that both females and males showed significant effects of social economic status on overweight and obesity. The participants' BMI scores were also analysed in terms of age and the results presented in Table 4.9.

Table 4.9 Distribution of mean BMI scores of the pupils by age

Age	N	Mean	Std.deviation
10	297	17.06	3.231
11	801	17.32	3.144
12	1383	17.63	3.149
13	1452	18.46	3.230
14	943	18.45	3.020
15	447	19.20	3.142

Table 4.9 shows that the mean BMI scores were different amongst the six-year groups. These different mean BMI scores are also shown in Figure 4.8.

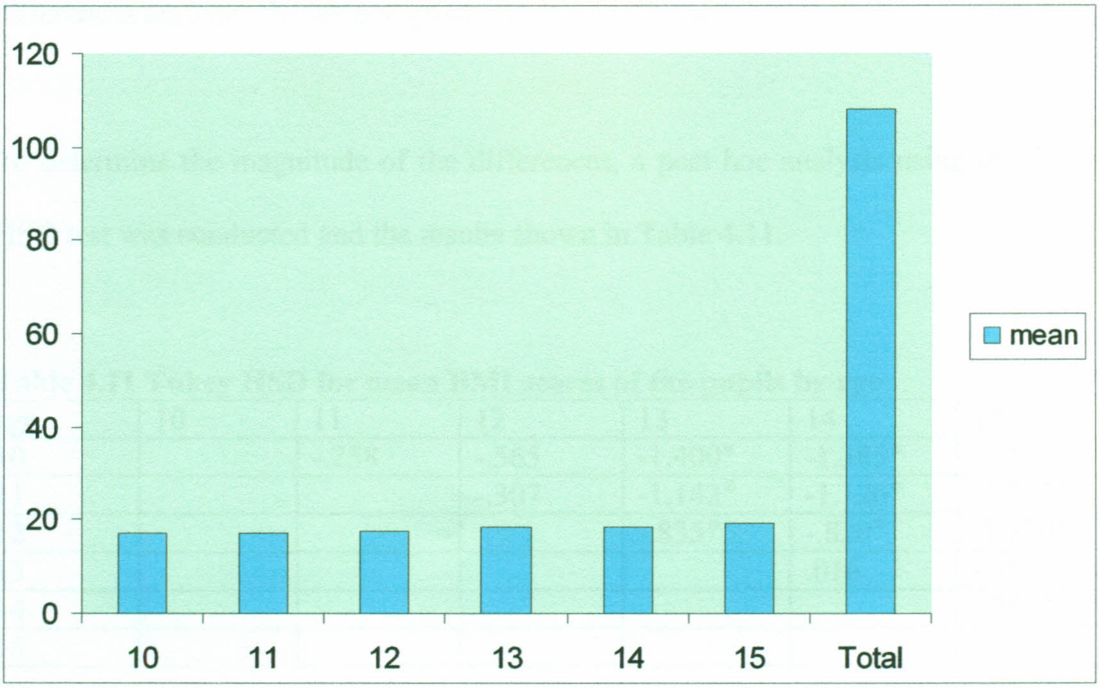

Figure 4.8 Mean BMI scores of the pupils by age.

The results indicated that pupils aged 10 years recorded the lowest mean BMI scores ($\overline{X}$=17.06±3.2), while pupils aged 15 years recorded the highest mean BMI score ($\overline{X}$=19.20±3.1). These results indicate that probably BMI scores increase with age. To test if the differences were statistically significant, one-way ANOVA was conducted and the results presented in Table 4.10.

Table 4.10 One-Way ANOVA for mean BMI scores of the pupils by age

	Sum of squares	df	Mean square	F	Sig
Between groups	1947.137	5	389.427	39.196	.000
Within groups	52827	5320	9.936		
Total	54774.205	5325			

$F(5, 5320) = 2.21$, at $p < .05$

The results in Table 4.10 were F (5, 5320) =39.20, at p<. 05 indicating that the differences amongst the six age groups were significant.

To determine the magnitude of the differences, a post hoc analysis using the Tukey HSD test was conducted and the results shown in Table 4.11.

Table 4.11 Tukey HSD for mean BMI scores of the pupils by age

age	10	11	12	13	14	15
10		-.258	-.565	-1.400*	-1.385*	-2.135*
11			-.307	-1.142*	-1.126*	-1.877*
12				-.835*	-.820*	-1.570*
13					.016	-.735*
14						-.751*
15						

Post hoc tests (Tukey HSD) indicated that mean BMI scores of children aged 10 years ($\overline{X}$= 17.06), 11 years ($\overline{X}$=17.32) and 12 years ($\overline{X}$=17.63) did not differ significantly. This can be explained by the fact that, during these ages (10, 11 and 12), children's growth is more uniform than during early childhood. Gormly and Brodzinsky (1990) indicate that, instead of large spurts in height or weight, size increases gradually from age six to ten or twelve, at which age there is a growth spurt. However, post hoc test results (Tukey HSD) indicate that mean BMI scores of children aged 10 years ($\overline{X}$=17.06), 11 years ($\overline{X}$=17.32) and 12 years ($\overline{X}$=17.63) differed significantly from those of children aged 13 years ($\overline{X}$=18.46), 14 years ($\overline{X}$=18.45) and 15 years ($\overline{X}$=19.20). This is because at these later ages (13, 14 and 15), there are increases in body weight and height as a result of growth in muscle and bone tissues as well as increases in fatty tissue (Gormly and Brodzinsky, 1990). Plowman and Smith (1997) also support the findings by their explanation that until approximately ages 10, cell size is similar in males and females but after age 10, the difference between males and females gradually widens as the rate of increase in fat cell accelerates. Plowman and Smith (1997) however note that the rate of increases in fat cell size after age 10 in females exceeds that of the males.

Mean BMI scores were also described for age and gender and the results shown in Table 4.12.

Table 4.12 Description of mean BMI scores of the pupils by age and gender

Age	Gender	N	Mean	Std.deviation
10	Male	188	16.81	3.293
	Female	179	17.23	3.187
11	Male	339	16.88	2.826
	Female	462	17.65	3.323
12	Male	660	17.15	3.081
	Female	723	18.06	3.150
13	Male	717	17.44	2.750
	Female	735	19.46	3.350
14	Male	523	17.48	2.610
	Female	420	19.65	3.065
15	Male	261	17.95	2.308
	Female	186	20.96	3.316

Table 4.12 shows that BMI means scores for males and females differed amongst all ages. This is further shown in Figure 4.9, where pupils aged 10 years are shown to have recorded the least mean and age 15 recording the highest in both cases.

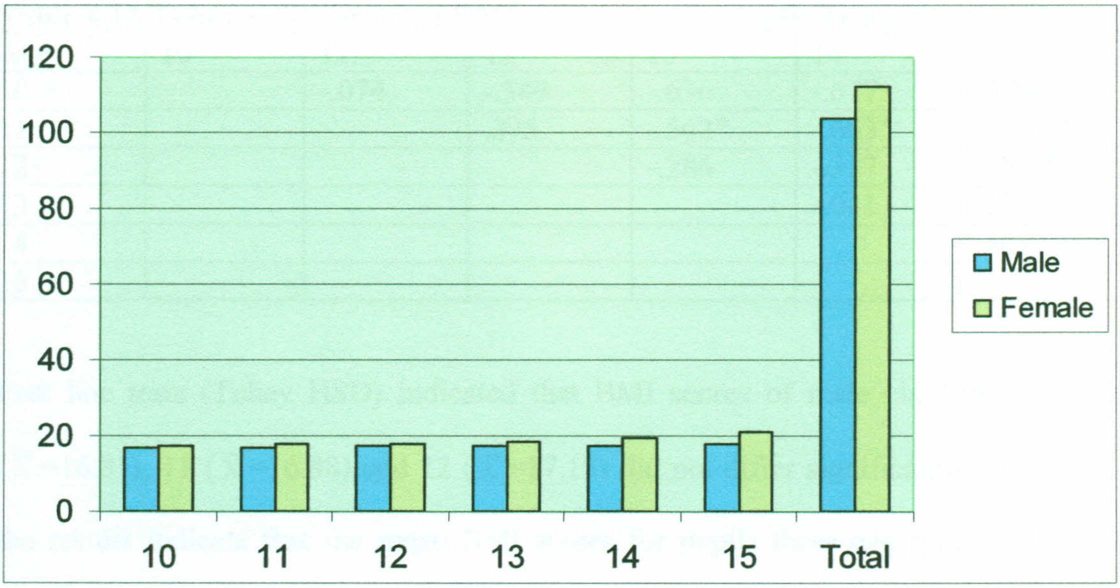

Figure 4.9 Mean BMI scores of the pupils by age and gender.

This indicates that childrens' BMI scores increase with age. To determine if the differences were statistically significant, one-way ANOVA was computed for males and females and the results presented in Tables 4.13 and 4.15, respectively.

Table 4.13 one-way ANOVA for mean BMI scores of male pupils by age

Gender		Sum of squares	df	Mean squares	F	Sig
Male	Between groups	241.723	5	48.345	6.135	.000
	Within groups	20581.352	2614	7.880		
	Total	20823.074	2619			

F (5, 2614) =2.21, at p<. 05

As shown in Table 4.13, F (5, 2612) =6.14, at p<.05 indicated that the differences in mean BMI scores amongst the 6 age groups were significant. Tukey HSD tests were conducted for this group and the results shown in Table 4.14.

Table 4.14 Tukey HSD for mean BMI scores of male pupils by age

Age	10	11	12	13	14	15
10		-.074	-.349	-.636	-.677	-1.141*
11			.275	-.562*	-.603*	-1.067*
12				-.286	-.327	-.792*
13					-.041	-.506
14						.465
15						

Post hoc tests (Tukey HSD) indicated that BMI scores of male children aged 10 ($\overline{X}$=16.81), 11 ($\overline{X}$=16.88) and 12 ($\overline{X}$=17.15) did not differ significantly. However, the results indicate that the mean BMI scores for pupils these age groups differed significantly with those of pupils aged 13 ($\overline{X}$=17.44), 14 ($\overline{X}$=17.48) and 15 ($\overline{X}$=17.95). The reason is as explained by Gormly and Brodzinsky 1990, that there are increases in body weight and height as a result of growth in muscle and bone tissues as well as increases in fatty tissue with increase in age. These increases are gradual from age 10 to 12 and then increases markedly thus peaking at age 15, and then slowly declining until age 20 or 21 for boys.

One- way ANOVA was conducted for the female subjects and the results presented in Table 4.15.

Table 4.15 One- way ANOVA for mean BMI scores of female pupils by age

Gender		Sum of squares	df	Mean squares	F	Sig
Female	Between groups	2935.643	5	587.129	56.06	.000
	Within groups	28267.103	2699	10.473		
	Total	31203.103	2704			

$F(5, 2699) = 2.21$, at $p < .05$

As presented in Table 4.15, F (5, 2699) =56.06, at p<. 05 the difference in mean BMI scores amongst the girls in the six age groups were statistically significant. Post hoc tests (Tukey HSD) were conducted and the results presented in Table 4.16.

Table 4.16 Tukey HSD for mean BMI scores of female pupils by age

age	10	11	12	13	14	15
10		-.413	-.828*	-2.228*	-2418*	-3.728*
11			.415	-1.815*	-2.005*	-3.310*
12				-1.400*	-1.590*	-2.895*
13					-.190	-1.494*
14						-1.305*
15						

Post hoc test results indicated that the mean BMI score of female pupils aged 10 ($\overline{X}$=17.23) differed significantly with those of pupils aged 12 ($\overline{X}$=18.06), 13 ($\overline{X}$=19.46) 14 ($\overline{X}$=19.65) and 15 ($\overline{X}$=20.96). The only age group that did not differ with age 10 was the group aged 11 years ($\overline{X}$=17.65). The results also indicated that mean BMI scores of pupils aged 13 and 14 years did not differ significantly. However, the mean BMI score of pupils aged 15 years differed significantly with those of all other age groups. These results indicate that BMI is age dependent and that it increases significantly with the increase in age. The changes in BMI with age are more evident in girls than in boys. This is because the changes in body weight and height as well as fat accumulation set early in girls such that at any age after 10 years they have more fat weight than boys (Berger and Thompson 1995). These authors support the fact that, girls reach the peak of the growth spurt at age 12 and 13 years and then slow down and usually cease completely between ages 15 and 18. However, the accumulated fat in the fat tissues remain high in girls such that by age 15 through 17 girls have two-fold as much body fat as boys. This explains the fact that the female subjects in the study had increasing BMI from the onset of the growth spurt and after.

4.2.7 Mean BMI, BIA and skin fold values for the experimental group

An experiment was then conducted to further assess body composition of the subjects who were classified as overweight and obese using the BMI measures. This was done using other body composition assessment techniques i.e. BIA and skin fold thickness. The aim was to establish the congruence of these three body composition measures in assessing overweight and obesity of children in the Kenyan children.

Additionally those subjects who were found to be overweight and obese using BMI measures were put on an exercise programme involving aerobic dance. The aim was to establish if the 10 weeks aerobic dance exercise programme would have any beneficial effect on body composition in 10-15 year olds. The pupils were divided into two groups: experimental and control groups. The results for BMI, BIA and skin fold were then described as follows.

Table 4.17 Description of mean BMI scores of the experimental group at pre-test and post-test by gender

Sex	N	(Pretest) mean BMI score $\overline{X}_1$	(Posttest) mean BMI score $\overline{X}_2$	Difference (D) in mean BMI Score $\overline{X}_1$-$\overline{X}_2$
Males	15	25.00	22.73	-2.27
Females	33	24.30	22.39	-1.91
Total	48	24.55	22.48	-2.07

Table 4.17 above shows that males recorded a higher mean BMI score than the female counterparts. However, both sexes recorded a higher BMI mean value at pre test of $\overline{X}$ = 25.00 and $\overline{X}$ =24.30 and $\overline{X}$ =22.73 and $\overline{X}$ =22.39 at posttest for male and female pupils, respectively. These different BMI mean scores at pretest are shown in Figure 4.10 below.

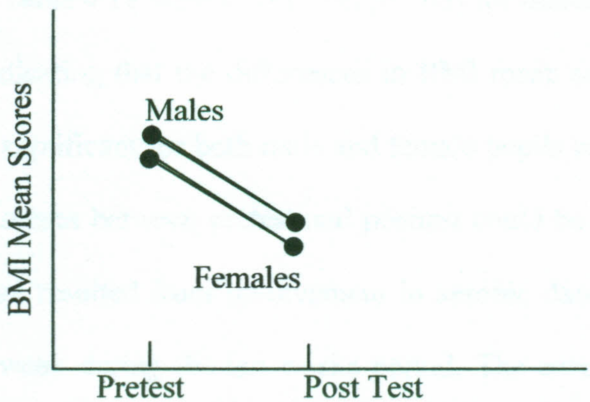

Figure 4.10: Mean BMI scores of the experimental group at pretest and posttest.

The results indicated a decrease in BMI mean score for both sexes with males recording a decrease of -2.27 and females recording a decrease of -1.97. This decrease showed that there could have been an effect of the aerobic dance exercises on BMI of the pupils. Again the decrease indicates that irrespective of gender, the response to physical activity was the same for both boys and girls. To establish if these differences in mean BMI scores between pretest and posttest were statistically significant, paired samples t-tests were conducted and the results presented in Table 4.18.

Table 4.18 Paired samples t-values for mean BMI scores of the experimental group for pre-test and post- test by gender

Gender	Pair	Mean difference	t	df	Sig.(2-tailed
Males	BMI -Pre BMI-post	2.27	7.55	14	.000
Females	BMI-pre BMI-post	1.91	17.39	32	.000

$t(14)=2.145$, $p<.05$ and $t(32)=2.04$, $p<.05$

The results in Table 4.18 were t (14) =14, p<. 05) for males and t(32) =17.39, p<.05) for females indicating that the differences in BMI mean scores between pretest and post test were significant for both male and female pupils respectively. The decreases in mean BMI scores between pretest and posttest could be attributed to daily energy expenditure that resulted from involvement in aerobic dance exercises for one hour three times a week during the ten weeks period. The energy expenditure following involvement in physical activity is supported by Howley and Powers (2001) who indicate that physical activity constitutes 5 percent to 40 percent of the daily energy expenditure.

Additionally, Foss and Keteyian (1998) observe that regular aerobic exercises even without dietary restriction bring about favourable changes in body weight and body composition. On the value of aerobic dance exercises these results concur with the findings by Mo-Suwan et al. (1998) who observed that a 29 week school based aerobic exercise program can prevent BMI gains in girls and may induce a remission of overweight and obesity in pre-school age children. However, the current study indicates that even shorter periods of time such as 10 weeks could result in observable changes in body composition of children as long as the recommended aerobic session time is adhered to. Again the current study suggests that it is not only girls who can benefit from involvement in aerobic exercises but boys also do respond to aerobic exercises. This is indicated by the change that was observed on BMI for both male and female pupils after participation in the 10 weeks aerobic dance exercise programme. The distributions of mean BIA scores of the experimental group at pretest and posttest by gender are presented in Table 4.19.

Table 4.19 Description of mean BIA scores of the experimental group at pre-test and post-test by gender

Sex	N	Pretest mean BIA % score $\overline{X}_1$	Posttest mean BIA% score $\overline{X}_2$	Difference (D)In mean BIA score $\overline{X}_1$-$\overline{X}_2$
Males	15	39.07	35.53	-3.54
Females	33	39.56	35.76	-3.80
Total	48	39.47	35.62	-385

Table 4.18 shows that females recorded a mean BIA score of $\overline{X}$= 39.66 and $\overline{X}$= 35.66 at pretest and posttest respectively. The values were greater than those of the males $\overline{X}$=39.07 and $\overline{X}$=35.53 at pretest and posttest respectively as shown in Figure 4.11.

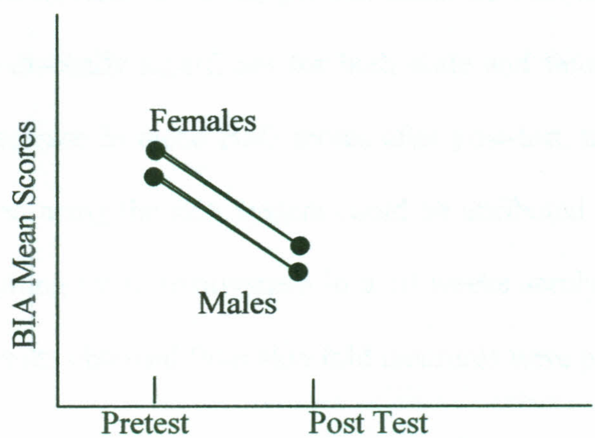

Figure: 4. 11 Mean BIA scores of the experimental group at pretest and posttest.

The values however decreased at posttest for both sexes with males recording a -3.54 decrease, and females recording -3.80 decreases. These results indicate that irrespective of gender, there were marked decreases in BIA scores between pretest and posttest. These results indicate that probably the involvement in the 10 weeks aerobic dance exercises elicited decreases in the percent body fat of the pupils assessed using the BIA system. To establish if these differences were statistically significant, paired samples t-test was conducted and the results presented in Table 4.20.

Table 4.20 Paired samples t-tests for mean BIA scores of the experimental group by gender

Gender	Pair	Mean difference	t	df	Sig.(2-tailed
Males	BIA -Pre BIA-post	3.53	5.98	14	.000
Females	BIA-pre BIA-post	3.80	5.60	32	.000

t (14)=2.145, p<.05 and t (32)=2.04, p<.05

Presented in Table 4.23 are the results i.e. t (14)=5.98, p<. 05) and t(32)=5.60, p<.05), indicating that the differences in the percent mean BIA scores between pre-test and post-test were statistically significant for both male and female pupils respectively. Similar to the decrease in mean BMI scores after post-test, the decreases in percent body fat estimated using the BIA system could be attributed to the changes in body composition resulting from involvement in a 10 weeks aerobic dance exercises. The distribution of results obtained from skin fold measures were presented in Table 4.21.

Table 4.21 Description of mean skin fold scores of experimental group at pre-test and post-test by gender

Sex	N	Pretest mean skin fold score	Posttest mean skin fold score	Difference (D) of mean skin fold score
Males	15	21.87	16.95	-4.92
Female	33	27.22	21.09	-6.13
Total	48	25.46	19.66	-5.8

Table 4.21 indicates that females recorded higher skin fold body fat values of ($\overline{X}$=27.14) and ($\overline{X}$=20.93) at pretest and posttest than their male counterparts who recorded values of ($\overline{X}$=21.87) and ($\overline{X}$=16.95) at pretest and posttest, respectively. These different mean percent skin fold values are also illustrated in figure 4.12 as follows:

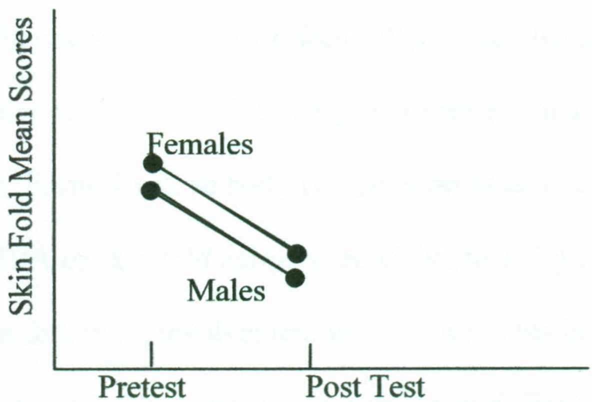

Figure 4.12 Mean skin fold percent scores of the experimental group at pretest and posttest.

Both sexes recorded a decrease in mean percent body fat. The values were -6.21 and -4.92 for females and males, respectively. These results suggest that irrespective of gender, changes in percent body fat following involvement in an exercise programme will result. To establish if these differences in mean percent body fat obtained using skin fold measures between pretest and posttest were statistically significant, paired samples t-tests were conducted and the results shown in Table 4.22.

Table 4.22 Paired samples t-values for mean skin fold values of the experimental group by gender

Gender	Pair	Mean difference	t	df	Sig.(2-tailed
Males	Skin fold - Pre Skin fold-post	4.92	8.56	14	.000
Females	Skin fold-pre Skin fold - post	6.14	14.99	32	.000

t (14)=2.145, p<.05 and t (32) = 2.042, p<.05

The results in Table 4.22 are t (14) =8.56, p<. 05) and t (32) =14.99, p<.05) indicating that the differences in mean percent skin fold scores between pretest and posttest were statistically significant for both males and females respectively. This decreases in percent body fat assessed using skin fold calipers are also attributed to the changes in body composition of the pupils following involvement in a 10 weeks aerobic dance exercise program. From the three body composition assessment methods it is evident that either BMI, BIA or skin fold calipers are viable techniques in tracking changes in body composition following involvement in exercises. This is so because at least each one of the methods was able to indicate a significant difference in body composition values between pre-test and post-test results. It is also evident that irrespective of gender, the three body composition assessment methods are viable in establishing changes in body composition following involvement in physical exercise.

On the value of aerobic dance exercises in changing body composition, the findings of the present study concur with those observed by Mo-Suwan et al. (1998) who found that low aerobic dance exercises are as useful as jogging or cycling in improving body composition of mildly obese middle aged women. However, the present study further indicate that, the value of aerobic dance exercises in changing body composition, hence reducing cases of overweight and obesity is not limited to adults only, but it can be used on children aged 10 to 15 years. Additionally, the present study indicates that aerobic dance exercises are not valuable only on females for weight management; rather it is an exercise mode that regardless of gender can yield similar effects on body composition.

4.2.8 Mean BMI, BIA and skin fold values for the experimental and the control groups

BMI, BIA and skin fold scores for the experimental and the control groups at pre-test and post-test were then described and the results presented in Table 4.23 and 4.24, respectively. This was done to establish if there were significant differences in these variables between the two groups. The results at pre-test were presented in Table 4.23.

Table 4.23 Means, standard deviations and independent samples t-values for BMI, BIA and skin folds of experimental and control groups at pre-test

Method	Group	n	$\overline{X}$	sd	t	df	sig
BMI	Control	21	24.50	3.50	-1.92	67	.061
	Experimental	48	24.52	3.61			
BIA	Control	21	39.38	7.08	-1.68	67	.098
	Experimental	48	39.41	7.89			
Skin fold	Control	21	25.51	4.12	-1.76	67	.088
	Experimental	48	25.55	4.89			

$t(67) = 2.021, p < .05$, $t(67) = 2.000, p < .05$ and $t(67) = 2.042, p < .05$

The results in table 4.23 indicate that, there were slight differences in mean scores between control and experimental groups amongst the three body composition assessment procedures at pre-test. The results indicate that, the mean BMI scores of the control group ($\overline{X}$=24.50) and the experimental group ($\overline{X}$ 24.52) differed slightly ($\overline{X}$=0.02). The results also indicate that the mean Percent BIA score of the control group ($\overline{X}$=39.38) and that of the experimental group ($\overline{X}$=39.41) differed slightly ($\overline{X}$=0.30). Further, the results in Table 4.23 show that the mean percent skin fold data of the control group ($\overline{X}$=25.51) and that of the experimental group ($\overline{X}$=25.55) differed slightly with a mean difference 0.04. To test if these differences were actually significant, independent samples t-tests were conducted for experimental and control groups and the results also shown in Table 4.23.

The results in Table 4.23 were t (67) =-1.92, p>.05) indicating that the difference in mean BMI between the control group and experimental group was not statistically significant at pre-test. This is because the two groups had similar characteristics in terms of body composition and were drawn from the overweight and obese population that was established using BMI in the first phase of the study.

Table 4.23 also shows that t (67) =-1.68, p>.05) indicated that the difference in mean percent BIA score between the control group and the experimental group at pre-test was not statistically significant. This is because the two groups had similar characteristics at pre-test in that they were drawn from the same group of overweight and obese pupils. Similarly, independent samples t-value for skin fold calipers was t (67) =-1.76, p>.05 as shown in Table 4.23. This indicated that the difference in mean percent skin fold score between control group and experimental group in pre-test was not statistically significant. The reason is that the subjects in these groups exhibited similar characteristics of overweight and obesity at pre-test.

BMI, BIA and skin fold mean scores of subjects in the control group and experimental groups obtained after post-test were then described and the results presented in Table 4.24.

Table 4.24 Means, standard deviations and independent samples t-values for BMI, BIA and skin folds of experimental and control groups at post-test

Method	Group	n	$\overline{X}$	sd	t	df	sig
BMI	Control	21	24.55	3.50	-3.76	67	.000
	Experimental	48	22.50	3.56			
BIA	Control	21	39.00	7.07	-4.30	67	.000
	Experimental	48	35.69	8.06			
Skin fold	Control	21	25.50	4.12	-5.12	67	.000
	Experimental	48	19.79	4.56			

The results in Table 4.24 show that at post-test, mean BMI score of control group ($\overline{X}$=24.55) and that of the experimental group ($\overline{X}$= 22.50) differed with a mean difference of 2.05. The results also indicated that there was a mean difference of 3.31 between the mean BIA score of the control group ($\overline{X}$=39.00) and the mean BIA score of the experimental group ($\overline{X}$=35.69). Similarly, there was a difference in mean percent body fat score ($\overline{X}$=5.808) between the control group mean score ($\overline{X}$=25.50) and experimental group ($\overline{X}$=19.79). These results indicate that there were changes in body composition of the pupils in the experimental group assessed through the three body composition evaluation procedures. The results also indicate that the body composition of the control group did not show any change between pre-test and post-test. To establish if these differences were significant, independent samples-test were conducted on each body composition evaluation methods and the results shown in Table 4.24. The result for BMI was t (67) = -3.76, p<. 05, indicating that the difference in mean BMI scores of the control group and the experimental group was significant. The difference in the two means is indicated by the fact that there was a significant decrease ($\overline{X}$=2.02) in the mean BMI score of the experimental group at post- test while the mean BMI score of the control group remained unchanged.

The result for BIA system was t (67) =-4.30, p<0.5) indicating that the difference in mean percent BIA scores between the control group and the experimental group was statistically significant. The difference in the two means is indicated by the fact that there was a significant decrease ($\overline{X}$=3.74) in the mean BIA score of the experimental group at post- test while the mean BIA score of the control group remained unchanged. This difference could be attributed to the involvement of the experimental group in 10 weeks aerobic dance exercises while no treatment with exercise was given to the control group.

The result for skin fold calipers was t (67) = -5.12, p<. 05) indicating that the difference in mean percent skin folds data between control group and experimental group was statistically significant. The difference is evidently shown by the significant variation in mean percent skin fold value ($\overline{X}$=5.76) of the experimental group between pre-test and post-test. On the other hand the mean percent skin fold value of the control group at pre-test and post-test remained significantly unchanged.

These significant differences in body composition of the pupils between pre-test and post-test assessed using BMI, BIA and skin fold calipers in the experimental group could be attributed to the increased caloric output following involvement of the experimental group in 10 weeks aerobic dance exercises. The lack of significant change in body composition of pupils in the control group between pre-test and post-test results is attributed to their lack of energy expenditure since they were not involved in the aerobic exercise programme. Therefore, it is evident from the results of the study that aerobic dance exercise programme can help children in using up calories which will consequently change their body composition beneficiary.

4.2.9 Tests of relationships

The three body composition testing procedures were inter-correlated to validate each one of them for use in Kenyan situation. Pearson product moment correlations were conducted and the results obtained presented in Tables 4.25 and 4.26 for pre-test and post-test, respectively.

Table 4.25 Pearson product moment correlation coefficients for BMI, BIA and skin fold measures at pre-test

	1	2	3
1		0.75*	0.57*
2			0.59*
3			

KEY
1-BMI
2-BIA
3-skin fold
*-significant

Table 4.25 shows that the correlation coefficients amongst BMI, BIA and skin fold ranged between r=0.57 and r=0.75. BMI correlated highly with BIA (r= 0.75) while BMI correlated moderately with skin fold measures (r= 0.57). BIA measures also correlated moderately with skin fold measures (r= 0.59). All these correlations were significant at 0.05 level. The hypotheses that there would be no significant relationship amongst the three-body composition testing procedures could not be accepted. Similar correlations were determined for BMI, BIA and skin fold measures for the post- test results and the findings presented in Table 4.26.

Table 4.26 Pearson product moment correlation coefficients for BMI, BIA and skin fold measures at post-test

	1	2	3
1		0.75*	0.55*
2			0.58*
3			

Table 4.26 above shows that at post-test, BMI and BIA values correlated highly (r= 0.75), while BMI correlated moderately with skin fold measures (r=0.55). The table also indicates that BIA correlated moderately with skin folds measures (r=0.58). These correlations were all significant at 0.05 level. Thus the hypotheses that there would be no significant relationships amongst the three-body composition testing procedures could not be accepted. These findings indicate that either BMI, BIA or skin fold measures is a viable technique in assessing body composition of children aged between 10 to 15 years. Furthermore, the findings indicate that either of the techniques could be used in the Kenyan set up to assess body composition amongst children. These findings in Table 4.25 and 4.26 were similar to the findings by Goss et al. (2003) who observed that correlations between skin folds and BIA system ranged from r= 0.51 and r=0.90, concluding that bioelectrical impedance may be a viable alternative field assessment technique that is comparable to skin fold measurement procedures. The results also agree with the findings by Utter et

al.(2001) who established the congruence between body composition obtained via skin folds and leg-to-leg BIA and obtained significant correlations (r=0.67 to r=0.83).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1.0 Introduction

This chapter presents summary of the findings, conclusions and recommendations.

5.2.0 Summary of the findings

This study assessed the prevalence of overweight and obesity amongst children aged between 10 to 15 years in private and public primary schools in Nairobi Province, Kenya. The study also determined the validity of leg-leg bioelectrical impendence system against skin fold measures and BMI in estimating body composition in overweight and obese children in the province. Additionally, the study further determined the association between age, gender and school with BMI. It was also of interest to assess changes in body composition of overweight and obese children in response to 10 weeks of exposure to aerobic dance exercise program.

To guide the achievement of the purpose, objectives were formulated and the following hypotheses derived.

$H0_1$ There would be no significant difference in BMI between female and male children aged between 10- 15 years.

$H0_2$ There would be no significant difference in BMI between males in private primary schools and males in public primary schools.

$H0_3$ There would be no significant difference in BMI between females in private primary schools and females in public primary schools

$H0_4$ There would be no significant difference in BMI of male and female pupils amongst the six age groups.

$H0_5$ There would be no significant relationship amongst BMI, BIA and skin fold measures in estimating overweight and obesity among children aged 10-15 years.

$H0_6$ There would be no significant difference in overweight and obesity status of children aged 10-15 years before and after treatment with aerobic dance exercises for a period of 10 weeks.

The study was conducted in two phases. The first phase involved assessing the prevalence of overweight and obesity amongst primary school children aged 10-15 years in Nairobi province, Kenya. The sample of the first phase included 5325 male and female pupils who were selected using the convenient sampling procedure from four randomly selected divisions of Nairobi province. Out of this sample, 1479 were drawn from private schools and 3846 from public schools. The sample also included 2705 girls and 2620 boys.

Data were collected through direct measurement of the pupils' body weight and height from which an index (BMI) was computed using the formula: Weight (kg)/Height (m^2). Age and gender specific percentile ranks were then determined using the WHO (2007) BMI-for- age growth charts and interpreted using the WHO (2007) percentile rank cut off points. The second phase of the study comprised pupils who were found to be overweight and obese during the first phase. Subjects included 69 pupils drawn from two private schools that were purposively selected. These pupils were divided into two groups: experimental group (48 pupils) and control group (21 pupils). The pupils in this phase were put on further assessments for their body composition using BIA system, BMI and skin fold calipers. This was done during the second term (May 2006). The experimental group was then put on a 10 weeks aerobic dance program. Each session lasted for one hour and was conducted three times per week in each school. After the 10th week, a post- test was administered to both experimental and control groups.

Data obtained were descriptively analysed using percentages, means and standard deviations. Inferential statistics was also used to further analyse the data; which included independent samples t-test, paired samples t-test, Pearson product moment correlations and analysis of variance. Resulting significant differences following ANOVA were subjected to Tukey HSD post hoc test in order to determine the specific group means that were significantly different from one another. Acceptance and rejection of the hypotheses was set at p<. 05 alpha level.

The major findings are presented on effects of gender on BMI, effects of age on BMI, congruence of BIA with BMI and skin fold and effects of 10 weeks aerobic dance exercise program on body composition.

5.2.1 Findings on effect of gender on BMI

The findings on effects of gender on BMI were as follows:

Female pupils in both private and public schools recorded higher mean BMI scores that their male counterparts in both private and public schools. The significant difference in mean BMI scores between males and females aged 10-15 years was due to the differences in the developmental changes that occur during the adolescent growth spurt with females accumulating and maintaining more fatty tissues than their male counterparts.

5.2.2 Findings on effect of age on BMI

The findings on effects of age on BMI were as follows.

a. Mean BMI scores of subjects aged 10,11 and 12 years differed significantly from those of pupils aged 13,14 and 15 years. This was because the former ages represent the onset of the growth spurt with its concomitant increases in body composition in the later ages 13, 14 and 15, after which there is a decline in weight and height gains for girls but which continues to age 17 for males.
b. When male pupils were assessed separately the significant difference in mean BMI scores was only evident between ages 10 and 15 years but not between ages 12 to 14 years. This is because the onset of the growth spurt in males starts later from 12 years and peaks at age 17 than that of females which starts as early as age 10 and peaks at ages 14 and 15 years.
c. When female pupils were assessed separately, the results indicated that there were significant differences in mean BMI scores of pupils aged 10,11 years, and those of pupils aged 12, 13, 14 and 15 years. This is because of the early onset of the growth spurt in females accounts for the significant difference between a child aged 10 years and the one aged 12 years because at age 12 most female pupils have already reached the peak of the growth spurt. The subsequent significant differences in mean BMI scores amongst 11 year olds and those aged 13, 14 and 15 years are as a result of fatty tissue that was accumulated in female

pupils which results in increased BMI scores even after the decline of the growth spurt.

5.2.3 Findings on the congruence of BIA, BMI and skin fold calipers in estimating body fat

The findings on the congruence of BIA, BMI and skin fold calipers in estimating body composition of children aged 10-15 years in Nairobi province, Kenya were as follows:

a. BIA system correlated significantly to BMI at pretest (r-0.75) and at posttest (r=0.75).
b. BIA system correlated significantly to skin fold calipers both at pretest (r=0.59) and at posttest (r=0.58)
c. Similarly, BMI correlated significantly to skin fold calipers at pretest (r=0.57) and at posttest (r=0.58).

These significant correlation coefficients indicated that either of these body composition assessment procedures is viable to assess body composition changes amongst Kenyan children.

5.2.4 Findings on effects of 10 weeks aerobic dance exercise program on overweight and obesity status

The findings on effects of 10 weeks exposure to aerobic dance exercises on body composition of children aged 10-15 years in Nairobi province, Kenya were as follows.

a. A10 weeks aerobic dance exercise programme resulted in decreases in body composition estimated using BIA system, BMI and skin fold calipers. These decreases were noted when pre-test results were compared with posttest results using paired samples t-test for the experimental group. The decreases were as a result of changes in body composition resulting in depletion of calories following regular involvement in the 10 weeks aerobic dance exercises.

b. When the experimental group was compared with the control group at post - test, there were significant differences in body composition of the pupils. However, no significant differences were observed when the two groups were compared at pre-test. These differences are explained by the fact that the experimental group could have shed some weight hence they experienced changes in body composition following involvement in the 10 weeks exercise program where as the control group did not participate in the aerobic exercise.

5.3 Conclusions

Based on the findings of the study, the following conclusions can be drawn:

Female pupils are more susceptible to overweight and obesity in Kenya as compared to their male peers. This is because they recorded higher mean BMI scores than their male counterparts in both private and public schools.

That children in private schools are more susceptible to overweight and obesity than their counterparts in public schools regardless of gender. This is indicated by the significantly higher mean BMI scores of the pupils in private schools than those in public schools.

There are differences in BMI scores amongst ages especially between ages 10 and 11years and 13, 14 and 15 years because of the progressive developmental changes that occur within the six years. These differences are accounted for by existence of different changes that occur in each year in the growth spurt.

The study also concludes that, due to the strong correlation coefficients obtained between BIA and BMI (r=0.75), BIA and skin fold calipers (r=0.59) and BMI and skin fold calipers (r=0.58), either of these body composition estimation techniques can provide a viable alternative for assessing body composition amongst children aged 10-15 years in Kenya.

The study also concludes that aerobic dance exercises provide a good exercise mode that can be used to cause changes in body composition of overweight and obese children in a Kenya and that a 10 weeks aerobic dance program can elicit increases in energy expenditure that causes decrease in body fat.

5.4 Recommendations

Based on the findings of this study, the following recommendations, which have implications for practice, policy change as well as further research, are made.

5.4.1 Recommendations for Policy change and Practice

Physical education teachers should ensure that they conduct regular evaluation on pupils' fitness status specifically on their body composition. This will not only help them in giving feedback but will also provide them with the pupils' physical fitness profiles. For instance they would be able to know the most prevalent conditions such as overweight and obesity and be able to provide intervention measures for their management.

For evaluation purpose, either BIA, BMI or skin fold methods should be used in estimating childhood overweight and obesity in Kenyan schools. However, the use of BIA is highly recommended by this study since it is simple, quick especially in school settings where the pupils' populations are large, inexpensive yet it is able to distinguish between lean tissue and fat tissue.

Physical education teachers should embrace the use of aerobic dance exercises in managing overweight and obesity among primary school children. This will be possible if the physical education teacher involve the pupils in aerobic dance exercises at least three times each week for 60 minutes through out the school terms.

The school administrators should create the link between the parents and the physical education teachers in order to develop follow up programmes on cases of overweight and obesity even after they leave school. This will provide a life long strategy of tracking body weight for such pupils.

5.4.3 Recommendations for further research

A nationwide study on overweight and obesity amongst children in Kenya should be assessed in order to have a general overview of overweight and obesity incidence in Kenya.

Further research on overweight and obesity need to be conducted on adults and children younger than 10 years since the findings of this study cannot be generalized to all populations.

There is need to also conduct a comparative assessment of overweight and obesity between rural and urban areas in Kenya so as to bring out the big picture on the prevalence of overweight and obesity in the country.

Additionally, there is need to assess the efficacy of other aerobic exercises in preventing and managing childhood overweight and obesity in Kenya. This will help enrich the existing physical education curriculum as well as prevent individuals from being drug dependant since there are many health issues related to overweight and obesity.

Since exercise is not the only overweight and obesity management strategy as indicated by WHO (1998), the study recommends that the efficacy of other weight management strategies such as dietary intervention and behaviour modification or a combination of both be assessed amongst Kenyan children.

The study also recommends further research into assessing the association of overweight and obesity to most chronic health conditions such as type II diabetes in Kenyan situation as well as develop an intervention measure through exercise.

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Appendix A:

Procedure for taking skin folds from different sites

Skin fold site	Description
Abdominal	Vertical fold 2cm to the right of and level with the umbilicus. The head of the caliper was not in the umbilicus
Triceps	Vertical fold over the belly of the triceps muscle. The arm was relaxed. The specific site was the posterior midline of the upper arm
Chest	The location for this site was half or a third distance between the anterior axillary line and the nipple for boys. The measurement was taken diagonally along the natural line of the skin
Suprailiac	A diagonal fold was measured in line with the natural angle of the iliac crest. The measurement was taken along the anterior axillary line just above the iliac crest
Thigh	The vertical fold was measured over the quadriceps muscle on the midline of the thigh. The measurement site was half the distance between the top of the patella and the inguinal crease

Appendix B:

Equations for computing the body density from skin fold thickness for girls

<u>3 sites</u>

D_b= 1.09942-0.0009929 (XI) + 0.0000023$(XI)^2$-0.0001392 (X2)

X1= Sum of triceps, suprailiac and thigh skin folds

X2= age in years

Appendix C:

Equations for computing body density from skin fold thickness for boys

3 sites

$D_b = 1.10938 - 0.0008267\,(X1) + 0.0000016\,(X1)^2 - 0.0002574\,(X2)$

X1 = sum of chest, abdomen, and thigh skin folds

X2 = age in years

Appendix D:

A sample of BMI evaluation protocol sheet

Name---

School---

Gender--

Age---

Weight-----------------------

Height-------------------------

Calculated BMI----------------

Appendix E:
A sample of body composition evaluation protocol sheet for experimental and control groups

Name--
Gender--------------------------------------
Age---

Pretest		Posttest	
Weight (kg)			
Height (m)			
Skin folds (mm)			
BIA percent body fat			

Appendix F:

Girls BMI for age percentiles (10-15 years)

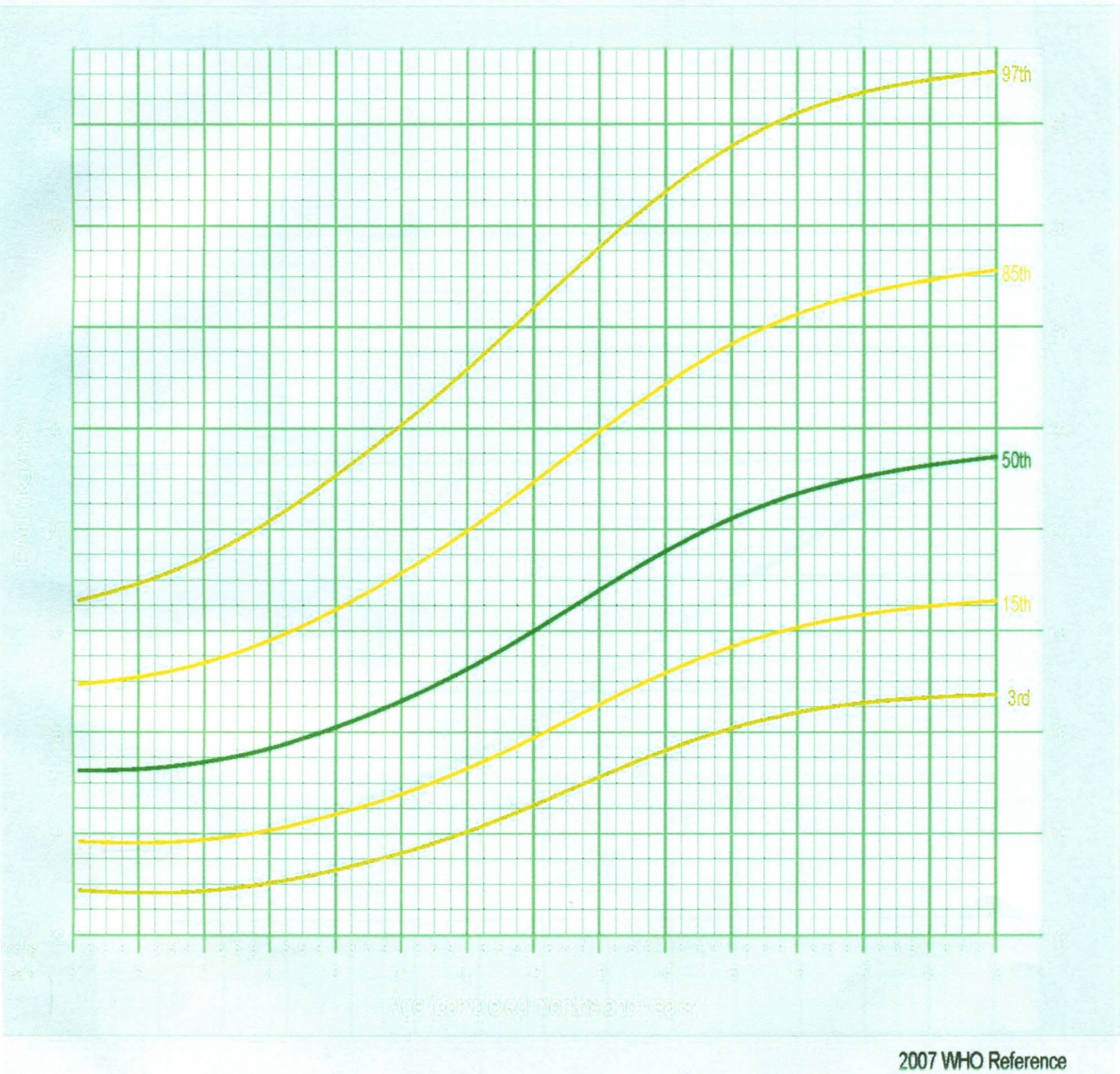
Age		Percentiles (BMI kg/m^2)										
Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
10	0	13.1	13.6	13.9	14.8	15.4	16.6	18.2	19.1	21.1	22.2	24.1
10	3	13.2	13.7	14.0	14.9	15.5	16.8	18.3	19.3	21.4	22.3	24.4
10	7	13.3	13.9	14.2	15.1	15.7	17.0	18.6	19.6	21.7	22.7	24.9
10	11	13.4	14.0	14.3	15.2	15.9	17.2	18.8	19.9	22.1	23.1	25.3
11	3	13.6	14.2	14.5	15.4	16.1	17.4	19.1	20.2	22.4	23.5	25.8
11	7	13.7	14.3	14.7	15.6	16.3	17.7	19.4	20.5	22.8	23.9	26.2
11	11	13.9	14.5	14.9	15.8	16.5	17.9	19.7	20.8	23.2	24.3	26.7
12	3	14.1	14.7	15.0	16.1	16.7	18.2	20.0	21.2	23.6	24.7	27.2
12	7	14.3	14.9	15.2	16.3	17.0	18.5	20.3	21.5	23.9	25.1	27.6
12	11	14.4	15.1	15.4	16.5	17.2	18.7	20.6	21.8	24.3	25.5	28.0
13	3	14.6	15.3	15.6	16.7	17.4	19.0	20.9	22.2	24.7	25.9	28.5
13	7	14.8	15.4	15.8	16.9	17.7	19.3	21.2	22.5	25.1	26.2	28.9
13	11	14.9	15.6	16.0	17.1	17.9	19.5	21.5	22.8	25.4	26.6	29.2
14	3	15.1	15.8	16.2	17.3	18.1	19.7	21.8	23.1	25.7	26.9	29.6
14	7	15.2	15.9	16.3	17.5	18.3	20.0	22.0	23.4	26.0	27.2	29.9
14	11	15.3	16.0	16.5	17.6	18.4	20.2	22.3	23.6	26.3	27.5	30.2
15	3	15.4	16.2	16.6	17.8	18.6	20.4	22.5	23.8	26.5	27.7	30.4
15	7	15.5	16.3	16.7	17.9	18.8	20.5	22.7	24.0	26.7	28.0	30.6
15	11	15.6	16.4	16.8	18.0	18.9	20.7	22.8	24.2	26.9	28.2	30.8

Appendix G:

Boys BMI for age percentiles (10-15 years)

Age		Percentiles (BMI kg/m^2)										
Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
10	0	13.4	13.9	14.1	14.9	15.4	16.4	17.7	18.6	20.2	21.0	22.7
10	3	13.5	13.9	14.2	15.0	15.5	16.6	17.9	18.7	20.4	21.2	23.0
10	7	13.6	14.0	14.3	15.1	15.6	16.7	18.1	19.0	20.7	21.6	23.4
10	11	13.7	14.2	14.4	15.2	15.8	16.9	18.3	19.2	21.0	21.9	23.8
11	3	13.8	14.3	14.6	15.4	15.9	17.1	18.5	19.4	21.4	22.2	24.2
11	7	13.9	14.4	14.7	15.5	16.1	17.3	18.8	19.7	21.7	22.6	24.7
11	11	14.0	14.6	14.9	15.7	16.3	17.5	19.0	20.0	22.0	23.0	25.1
12	3	14.2	14.7	15.0	15.9	16.4	17.7	19.3	20.3	22.3	23.3	25.6
12	7	14.3	14.9	15.2	16.1	16.6	17.9	19.5	20.6	22.7	23.7	26.0
12	11	14.5	15.0	15.4	16.3	16.9	18.2	19.8	20.9	23.1	24.1	26.4
13	3	14.7	15.2	15.5	16.5	17.1	18.4	20.1	21.2	23.4	24.5	26.9
13	7	14.8	15.4	15.7	16.7	17.3	18.7	20.4	21.5	23.8	24.9	27.3
13	11	15.0	15.6	15.9	16.9	17.5	18.9	20.7	21.8	24.1	25.2	27.7
14	3	15.2	15.8	16.1	17.1	17.8	19.2	21.0	22.1	24.5	25.6	28.1
14	7	15.3	16.0	16.3	17.3	18.0	19.5	21.3	22..4	24.8	25.9	28.4
14	11	15.5	16.1	16.5	17.5	18.2	19.7	21.6	22.7	25.1	26.3	28.8
15	3	15.7	16.3	16.7	17.7	18.4	20.0	21.8	23.0	25.5	26.6	29.1
15	7	15.8	16.5	16.9	17.9	18.7	20.2	22.1	23.3	25.8	26.9	29.4
15	11	16.0	16.7	17.0	18.1	18.9	20.4	22.4	23.6	26.1	27.2	29.7

Appendix H:
WHO (2007) BMI percentile rank charts for girls



Appendix I:
WHO (2007) BMI percentile rank charts for boys