# USING A MOBILE HEALTH SOFTWARE IN IMPROVING DIET QUALITY AND PHYSICAL ACTIVITY AND NUTRITION STATUS AMONG YOUTH IN NAIROBI, KENYA

**BY**

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**A THESIS SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, DEPARTMENT OF HUMAN NUTRITION IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF PUBLIC HEALTH**

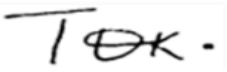
**MOI UNIVERSITY**

**2020**

## DECLARATION

**Declaration by the Candidate**

I declare that this is my original work and has never been presented for a degree in any other university or institution of higher learning.

**Sign**:  **Date**: 30/11/2020

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## DEDICATION

I dedicate this work to God Almighty, for His sustenance, strength, and grace to complete. Also, to my husband Zachary and my son Keon for cheering me on at the finish line. To my mother Grace who single-handedly raised us when our father passed away, my sister Phylis, my family and friends: Priscah, Ben, Raymond, Nellie, Mary, Doris, Pauline, Francis, Phanice, Brian, Rachel, Bonie, Allan, Emily, Carol, Joanna, Mary, Peter, Andrew and Mathew for their emotional support throughout this journey.

## ABSTRACT

**Introduction**: Socioeconomic transitions globally and in Kenya have an influence on lifestyles including dietary choices and physical activity. These changes can be linked to increasing trends in morbidity and mortality associated with overweight, obesity and non-communicable diseases (NCDs) such as diabetes and cardiovascular disease. Key prevention strategies include being physically active and eating a healthy diet. Several strategies have been employed tackle the problem including the use of innovative m-health (MH) technology. However, the application of these technologies in developing countries such as Kenya is limited.

**Objective:** The purpose of this study was to determine whether the use an MH software could improve diet quality and physical activity and consequently lead to weight-loss among youth aged 18-35 years living in Nairobi.

**Methods:** A randomized controlled trial approach was adopted; where baseline data on diet quality, physical activity (PA) levels, Basal Metabolic Index (BMI) and waist circumference (WC) was collected, and follow-up data after six and twelve weeks. Young adults with no apparent underlying condition deemed unsafe for the study, with BMI>24.9KgM$^{-2}$ aged 18 to 35 years from 5 institutions of higher learning were recruited (N=72; male=12, female=60). Subjects were solicited by volunteerism. Participants were randomly allocated into either the experimental (app) or control (diary) groups by tossing a coin. Diet quality was assessed using the Rapid Eating Assessment for Patients-short version (REAP-S), while physical activity was measured using the International Physical Activity Questionnaire (IPAQ) and weight-loss was assessed using BMI and WC. Baseline and follow-up means were compared using independent t-Test between groups and repeated measures ANOVA within groups. Relationship between app or diary use and improved diet quality, physical activity and nutritional status was examined using multiple linear regression. $P < 0.05$ was considered significant.

**Results:** There was a statistically significant improvement in diet quality (REAP-S P=0.001) and physical activity (MET-Min/Week P=0.001) for participants using the app at the 6$^{th}$ week. However, this was not sustained up to the 12$^{th}$ week (REAP-S P=0.33; MET-Min/Week P=0.18). Although participants using the app lost weight, the difference was not statistically significant when compared to those in the control at both 6 and 12 weeks (WC P=0.300; BMI P=0.070) and (WC P=0.38: BMI P=0.18) respectively. Multiple regression analyses also revealed adherence to the app did not significantly predict improvement in diet quality (REAP-S: $\beta$=0.46 t (70) = 0.372, ns) and physical activity (MET-min/week: $\beta$=-0.016, t (70) =-0.0131, ns). Quantitative data revealed: more than half participants found the app "moderately satisfactory" (76%) and "moderately easy" to use (81%). However, comments raised showed discontentment with functionality of the app.

**Conclusions and recommendations:** The study found the app to be effective in improving diet quality and physical activity at 6 weeks, but results were not sustained in the long run. However, the app was not effective in helping users achieve significant weight-loss compared to control. This research provides evidence that warrants the recommendation to use MH technology to address issues of healthy eating and physical activity in policy and practice. The app used in this study had major functionality concerns that require to be addressed opening it to use by the public.

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ART: | Antiretroviral therapy |
| BMI: | Body Mass Index |
| CAK: | Communications Authority of Kenya |
| CBD: | Central Business District |
| CVD: | Cardiovascular disease |
| DASH: | Dietary Approaches to Stop Hypertension |
| GPS: | Global Positioning System |
| IPAQ: | International Physical Activity Questionnaire |
| IHL: | Institution of Higher Learning |
| IT: | Information Technology |
| KDHS: | Kenya Demographic Health Survey |
| LMICs: | Low and Medium-Income Countries |
| MET-MIN: | Metabolic minutes |
| MetS: | Metabolic Syndrome |
| NCDs: | Non-communicable diseases |
| PA: | Physical activity |
| PRECEDE: | Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation |
| PROCEED: | Policy, Regulatory and Organizational Constructs in Educational and Environmental Development |
| REAP-S: | Rapid Eating Assessment for Patients (short version) |
| SSA: | Sub-Saharan Africa |
| UN: | United Nations |
| UNFPA: | United Nations Population Fund |

| | |
|---|---|
| WB: | World Bank |
| WC: | Waist Circumference |
| WHO: | World Health Organisation |

## DEFINITION OF TERMS

**Adherence:** the process of closely following or observing a given set of guidelines (Oxford Dictionaries, 2016). In this study, adherence will be measured in terms of number of days a user uses the application to record food intake and physical activity.

**BMI:** Body mass index is derived from a person's weight and height. It is the body mass in Kilograms by the square of the body height in metres and is universally expressed in units of $kg/m^2$. A person with BMI is less than 18.5, is considered underweight. 18.5 to <25, has a normal BMI, while BMI 25.0 to <30, they are overweight range. If your BMI is 30.0 or higher, it falls within the obese range.

**Diet quality:** Refers to how well a person's diet conforms to the recommended for their population group. For this study diet quality will be measured using the Rapid Eating Assessment for Patients short version (REAP-S) questionnaire.

**Institution of higher learning:** a college or university (Merriam-Webster Dictionary, 2017).

**Malnutrition**: according to the WHO, this refers to deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. This can be either 'undernutrition'—which includes stunting (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals) or 'overnutrition' – overweight (BMI>24.9 to <30) and obesity (BMI>30). This study focuses on overweight, obesity and diet-related noncommunicable diseases.

**Metabolic minutes:** A MET is a multiple of the estimated resting energy expenditure of an individual. One MET is what is expended at rest. According to the IPAQ scoring protocol (http://www.ipaq.ki.se/) to get a continuous variable score from the IPAQ

(MET minutes/week) walking is considered 3.3 METS, moderate physical activity is 4 METS and vigorous physical activity is 8 METS.

**Nutrition status:** the condition of the body in those respects influenced by the diet, which will be measured in terms of body mass index (BMI) and waist circumference (WC) for this study

**Physical activity:** bodily movement produced by skeletal muscles which results in energy expenditure. For purposes of this study, physical activity be measured using the international physical activity questionnaire (IPAQ)

**Smartphone web application (app):** a self-contained software program designed to fulfil a particular purpose, especially as downloaded by a user to a mobile device.

**Smartphone:** mobile phone that is more advanced and has features like: internet access, built-in GPS, and high-resolution cameras. Smartphone devices can run compact software programs known as "apps".

**WC:** Waist circumference is a marker of abdominal obesity, that is obtained by measuring the abdomen at the level of the superior iliac crest with a tape measure. It is an indicator of risk for metabolic syndrome related NCDs such as diabetes and hypertension. For men WC >102 cm (40 in.) and Women WC>88 cm (35 in.) indicates high risk.

**Youth:** The United Nations defines "youth" as a person between 15 and 24 years of age for statistical purposes without prejudice to other definitions by Member States. According to the definition given in the African Youth Charter (UN Fact Sheets, 2001), "youth" means "every person between the ages of 15 and 35 years". This study adopts a definition "young adult" based on the African Youth Charter, which shall be a person between the ages of 18 and 35 years.

## ACKNOWLEDGEMENTS

I would like to thank faculty of Moi University faculty who were valuable assets as they took us through the demanding coursework. More specifically, I would like to thank my supervisors: Dr. Susan Keino and Dr. Lucy Kiyiapi for their important insights and tireless assistance throughout my research process. In addition, I would like to appreciate and Dr. Zeinab Gura and Providence Kiptoo for wholeheartedly helping me out on key areas in this research work. I am also grateful to Dr. Peter Rugano of Embu University for his insights during the shaping up of my concept. Finally, I am thankful to Africa Hub, a project under Health Alliance for the award of a stipend towards my research expenses

# CHAPTER ONE:

# INTRODUCTION

## 1.1 Background

Kenya is a developing country that has recently been classified as a middle income country (World Bank, 2015). Rapid economic development has resulted in significant demographic as well as socioeconomic changes. These changes have brought about a transition in nutritional habits and physical activity patterns (Onywera et al., 2012). Nutrition transition is characterized by large shifts in diets; from the consumption of diets rich in natural foods such as fruits, vegetables and whole grains to increased consumption of processed foods that are high in sugar, salt and saturated fat and low in polyunsaturated fats and fibre (Monteiro, Conde, & Popkin, 2004). This is often accompanied by an increase in sedentariness (Bell, Ge, & Popkin, 2001). Unhealthy, processed foods are becoming increasingly available and accessible geographically and financially for most Kenyans especially in urban areas like Nairobi(Kigaru, Loechl, Moleah, Macharia-Mutie, & Ndungu, 2015).

Too much consumption of these foods is the leading cause of poor health outcomes including overweight, obesity, and non-communicable diseases (NCDs) like type II diabetes, cardiovascular diseases and some cancers (World Health Organisation, 2003). NCDs are responsible for almost 70% of deaths worldwide and each year. 75% of these deaths occur in low and middle income countries (World Health Organization, 2014a). According the same report by the WHO, NCDs were the leading cause of death and hospital admissions in Kenya in 2012.

Kenya, like most developing countries is also experiencing a double burden of disease and malnutrition (Norris, Wrottesley, Mohamed, & Micklesfield, 2014). Infectious diseases like HIV, malaria and tuberculosis continue to be a burden on the health system

and now in addition there is a rising epidemic of NCDs (World Health Organization, 2014b). Also, stunting and underweight are a major concern in Kenya, yet similarly high proportions of the population are overweight or obese (*Kenya Demographic Health Survey*, 2014).

The increasing morbidity and mortality due to overweight, obesity and NCDs in Kenya, and their economic as well as social implications mandate the need for introduction of newer innovative technology to tackle the problem. With the ever-growing user base of mobile phones in Kenya, m-Health technology seems to be a viable option in delivering health interventions to address the threat of NCDs resulting from unhealthy lifestyles. Up to date, there are numerous apps to address diet tracking and weight loss. A search on the Google Play store app alone by the keyword "weight loss" returned over 500 results (July, 2017). However, most of these are simply caloric counters that help users track their energy intake without much consideration to the food group. Also since they are developed in the Western World, thus their application in a Kenyan setting is a bit challenging due to a cultural variation in diets consumed. Therefore, this warranted the development of new software (Superfit app) that would be practical to use in the Kenyan setting.

The Superfit app was custom made for the purposes of this study. The aim was to help users adopt an overall healthy lifestyle by monitoring their dietary intake and physical activity. Users accessed the app on online, signed-up and used it to track their diet, exercise and progress toward improving their nutritional status. The purpose of this study was to determine whether the Superfit web application could promote lifestyle changes that encourage good dietary habits and physical activity.

## 1.2 Problem Statement

According to the Global Nutrition Report, (2016), the burden of overweight, obesity and NCDs in Sub-Saharan African (SSA) countries has been increasing rapidly. Although the Report rates Kenya among the countries with lower rates of overweight and obesity, remarkable concerns arise when statistics from the Kenya National Bureau of Statistics (KNBS) are considered. It is worth noting that the national prevalence of overweight and obesity (BMI $\geq$25kg/$m^2$), among women aged 15-49 years rose in less than a decade; from 25% (Kenya Demographic Health Survey [KDHS], 2008) to 33% (KDHS, 2014). The KNBS findings also indicate urbanization is a major driving force for overweight and obesity as the prevalence of overweight and obesity in Nairobi is 47% (KDHS, 2014); which is the highest nationally among women in this age group. In addition, those with higher education levels and those of higher socioeconomic status were more likely to be overweight or obese.

Disturbingly, the trend of overweight, obesity and NCDs is increasingly affecting youth in Kenya (WHO, 2014). This trend may be explained by poor eating habits and sedentary lifestyles formed during childhood. A couple of studies carried out in Nairobi indicate school-going children consume unhealthy foods and snacks and rarely meet the Kenyan Ministry of Health recommended physical activity guidelines; a trend which is carried into adolescence and adulthood. According to Kigaru et al., (2015) the situation is made worse by availability of unhealthy foods and snacks in school cafeterias, shopping malls and on the streets where young people spend most of their time.

The rapid rate of change in overweight, obesity and non-communicable disease pattern and disease burden in Kenya is a public health threat that demands immediate action. Obesity is largely preventable through diet modification and physical activity.

However, in spite of knowledge on benefits of diet and physical activity, most people are usually unable to make the necessary lifestyle changes (Strecher, DeVellis, Becker, & Rosenstock, 1986).

Many strategies have been used by to solve the weight loss puzzle including; dieting, surgeries, the use of medications and various technologies. Dieting is the most popular method worldwide because it is easy to start, can quickly yield results, and may be relatively inexpensive to follow (Scholtz, 2016). Although weight loss seems to be a simple arithmetic equation where one needs to consume less energy than they use, this notion does not pay attention to the nutritional value of the food consumed. A good weight loss regime should therefore underscore importance of a nutritious diet. However, weight loss is usually difficult to maintain beyond any intervention (Beck and Haigh, 2014). This is usually as a result of incorporation of few or no behaviour change techniques such as; self-monitoring, health promotion, support group and goal setting in interventions. All these techniques may be difficult to integrate in a single weight-loss regime, but using technology, it is possible to develop apps while incorporating these techniques. These apps run on mobile devices such as Smartphone devices and can be accessed in different locations at the user's convenience and can therefore be useful in helping clients maintain their weight loss regimes. Many Smartphone apps have been developed for this purpose and are available for free use. However, most of these are mainly caloric counters that help users determine and control the energy consumed through their diets, without addressing the nutritional value of what the users consume. This informed the need to develop a new application that would help clients assemble meals based on an overall healthy diet.

## 1.3 Justification

The Step Wise Report by Kenya Ministry of Health, (2015) found that the NCDs were not only a threat to the health of Kenyans but were also straining Kenyans financially and slowing down the economic progression of the country by up to six per cent (Kenya Ministry of Health, 2015). This could cripple the country's economy if nothing is done to address the challenge. The Kenyan Government has policies on dietary and physical activity guidelines. These guidelines may not however be sufficient for the problem of overweight and obesity that is currently increasingly affecting Kenyans. More concrete dietary interventions are required to encourage weight loss and maintenance of healthy weight for the general Kenyan population. The findings of this study will help inform policy on interventions that will promote healthy lifestyles.

In the long run, overweight and obesity reflect energy imbalance (Hall et al., 2012). Therefore, the major areas for intervention are related to dietary intake and energy expenditure (physical activity). Many public health interventions such as policy changes, awareness creation and treatment, targeting physical activity and dietary changes have been used and have had modest long term effects (WHO & Public Health Agency of Canada, 2005). This may be linked to limited use of behaviour change techniques in these interventions (Michie et al., 2011).

The use of mobile phone health (m-Health) technology is a growing area in the prevention and management of NCDs and holds potential to deliver health-related behaviour change interventions (Steinhubl, Muse, & Topol, 2013). Benefits of m-Health include; persistent interactivity, personalization and engagement, potential to make healthcare more accessible and scalable, more cost effective and more equitable (Whittaker, 2012).

Mobile phone penetration and ownership in Kenya continues to grow and will soon reach saturation. The Communications Authority of Kenya (CAK) reported 88.1% mobile phone penetration in the first quarter of financial year 2015/2016. The same report estimates the number of internet users in Kenya to be 31.9 million, which means 74.2 per 100 inhabitants had access to internet during that period (CAK, 2015). Kenyans are increasingly embracing Smartphone devices as their companions (Poushter, 2016). Applications that run on Smartphone devices can be used to improve people's quality of life by enhancing convenience (Ozdalga, Ozdalga, & Ahuja, 2012). Since according to Jarl & Moberg Lundén, 2(015), youth spend a lot of time on their Smartphone devices and use applications on these devices to communicate via social media, watch videos, or play games, the ubiquitous power of mobile phone penetration and increased use by youth in Kenya can be harnessed and used to deliver lifestyle change interventions targeting healthier lifestyles to reduce the prevalence of overweight, obesity and NCDs in Kenya.

### 1.4 Broad Objective

The purpose of this study was to determine whether the use of a Smartphone web application could be effective in helping overweight youth modify diet and physical activity related behaviour in order to trigger weight-loss.

### 1.5 Specific Objectives

1. To evaluate the use of an m-Health software in improving the quality of diets consumed by a sample of youth living in Nairobi County.
2. To assess the use of an m-Health software in improving the physical activity of a sample of youth living in Nairobi County.

3. To evaluate the use of an m-Health software to improve nutrition status for a sample of overweight youth living in Nairobi County, using a Smartphone web application to monitor their diets and physical activity.

### 1.6 Null Hypotheses

1. There will be no difference in the diet quality of the sample of youth who use m-Health software and those in the control group.
2. There will be no difference in the physical activity of the sample of youth who use the m-Health software and those in the control group.
3. There will be no difference in the weight-loss (BMI and waist circumference) of the sample of youth who use the m-Health software and those in the control group

### 1.7 Research Question

Can the Superfit web application help promote lifestyle changes that encourage good dietary habits and physical activity and consequently lead to weight-loss for a sample of youth from Nairobi County?

# CHAPTER TWO:

# LITERATURE REVIEW

## 2.1 Introduction

Lifestyle changes as a result of modernization and urbanization in developing countries such as Kenya have led to increased prevalence of overweight, obesity and non-communicable diseases (WHO, 2014a). If measures are not taken to address this challenge, these poor health outcomes will continue to overwhelm the existing fragile health systems in these countries, as well as threaten their economic growth hence sustainable development.

The period of young adulthood seems to be the most suitable time to intervene in moving towards achieving healthy lifestyles for populations. Adolescence and young adulthood is often a period of self-discovery and identity formation; when lifelong behaviour patterns are initiated, established and are likely to be carried through to adulthood (World Health Organization, 2009) . In a policy brief by the Population Reference Bureau; Naik & Kaneda, (2015) concluded that interventions targeting the social and economic precursors of NCD risks, those that encourage positive health behaviours such as healthy eating and regular exercise, and discourage negative ones such as smoking in young people were paramount if the projected course of NCDs in Africa is to be shifted.

This section addresses the literature background for this research by means of the following topics: the problem of overweight, obesity and NCDs, interventions currently used in the prevention and management of overweight and obesity, diet quality, physical activity, nutritional status, interventions used in prevention and management of overweight, obesity and NCDs and the use of m-health in prevention and management of overweight and obesity.

## 2.2 The Problem of Overweight, Obesity and Non-Communicable diseases

Globally, over the last few decades, people's eating habits have drastically evolved from diets rich in legumes, vegetables, and whole grains to those high in refined carbohydrates, added sugars, fats, and animal-source foods (Popkin et al., 2012). Moreover, access to technology has caused a reduction in energy expenditure during work, transportation, leisure activities and household tasks (Monda, Adair, Zhai, & Popkin, 2008). This transition in lifestyles is the major cause of metabolic syndrome (Met-S) characterized by overweight, obesity as well as some NCDs including cardiovascular diseases, cancer and diabetes. The WHO defines overweight and obesity as abnormal or excessive fat accumulation that may impair health (WHO Fact Sheets, 2016). Generally, obesity and overweight are determined using the body mass index (BMI), a person's weight (in kilograms) divided by the square of his or her height (in metres). If a person has a BMI of 30 or more, they are considered *obese*, while a person with a BMI equal to or greater than 25, but less than 30 is considered overweight. Met-S on the other hand can be defined is a cluster of abnormalities that include: obesity, blood sugar metabolic disorder, hypertension, and heterogenic dyslipidemia; whose most important risk factors include smoking, unhealthy diets, inactivity and alcoholism (Esmailnasab et al., 2012).

In 2014, 1.9 billion of the world's adult population was overweight or obese (BMI≥25); about 32% of this population was obese (BMI≥30) (World Health Organization, 2014a). Overweight and obesity are highly associated with NCDs which are the leading cause of death globally. They were responsible for 38 million (68%) of the world's deaths in 2012 (WHO, 2014a). More than 40% of 38 million people who died in 2012 of NCDs were premature deaths of people under the age of 70 years.

Although communicable diseases such as HIV/AIDS continue to prevail in Africa, especially in the Sub-Saharan region, NCDs are projected to be the leading cause of death by 2030. Already in North Africa, NCDs account for more than 75% of all deaths and nearly half of the population in SSA suffers from hypertension (World Health Organization, 2014b). Obesity and overweight are also showing worrying trends as not only do they affect a large proportion of people globally but also because they have started to appear earlier in life. According to WHO 12.7% of African children will be overweight or obese by 2020 (Mercedes de Onis, Monika Blössner, Elaine Borghi, 2010).

Non-communicable diseases account for 27% of deaths suffered by those aged between 30 and 70 years in Kenya. This is equivalent to almost 100,000 people per year with the potential to reduce productivity, curtail economic growth and trap the poorest people in chronic poverty. 50% of all hospital admissions and 55% of hospital deaths in Kenya are estimated to be due to NCDs (World Health Organization, 2014b). It is estimated that between 2011 and 2025, NCDs will result in cumulative economic losses of up to US$ 7 trillion if nothing is done. This sum far outweighs an annual US$ 11.2 billion cost of implementing a set of high-impact interventions to reduce the NCD burden (World Health Organization, 2014a).

Urbanization is the driving force behind changing lifestyles; the main factor linked to NCDs. According to the KDHS, (2014), 42.3% of women between ages 15 and 49 years living in urban areas compared with 25.8% of their counterparts in rural areas were found to be either overweight or obese (BMI≥25Kg M-2). Among all the provinces, Nairobi's 47.6% was the highest proportion of overweight and obesity.

Another worrying trend is that overweight, obesity and NCDs are starting to affect younger people. Several studies carried out in Nairobi indicate that the prevalence of NCDs is quite high among young people. A study carried out by Kimani-Murage et al., (2015) in a slum in Nairobi found that the proportion of overweight and obesity among younger adults (18 to 29 years) was 17.1%. Another study by Joshi et al., (2014) in Kibera slum in Nairobi had subjects with a mean age of 33.4 years. The age-standardised prevalence of hypertension (95% CI) was found to be 22.8% (20.7, 24.9). Among this group, 5% reported that they had diabetes; which was consistent with the findings of another study carried out by Ayah et al., (2013) in the same area, which found the age-adjusted prevalence of diabetes was found to be 5.3% (95% CI 4.2-6.4). The prevalence increased with increasing age and peaked at 10.5% (95% CI 6.8-14.3%) in the 45–54 year age category.

In summary, the rising burden of NCDs among youth in Kenya can be attributed to poor diets as a result of nutrition transition, low physical activity levels and socio-cultural factors. Research findings indicate that NCDs are increasingly affecting either youth or people in their middle ages; thus validating Flynn et al.'s, (2006) findings that NCDs result from dietary practices which are mainly formed during childhood. Therefore interventions and policy targeting NCDs should be targeted towards young people. Unless the challenge of overweight and obesity is addressed, the health system in African countries will continue to suffer hampering economic development and growth. The sustainable development goals will continue to be out of reach for Kenya since the health and well-being of a country's population is key in achieving these SDGs.

## 2.3 Demographic, Socio-Economic and Cultural Determinants of Nutritional Status of Youth

The lifestyles of young people living in Sub-Saharan African countries making the socioeconomic shift are affected by the social, cultural and environmental factors such as education, financial independence and social norms (Poobalan & Aucott, 2016). Sub-Saharan Africa is the only region in the world with a growing young population. This 'youth bulge' which is as a result of reduced mortality and high fertility rates is seen as the driver of economic development in SSA. This is because youth contribute to the labour market and are consumers of the products (UNFPA, 2014). SSA's per capita income has grown at a faster rate than the global average in the last decade, thus propelling economic growth. Between 2003 and 2008, before the global financial crisis, income per capita in the region grew 5% a year, more than twice the rate of the 1990s (Malik, 2013). In spite of rapid population growth, economic development in SSA has been sufficient to allow modest improvements in living standards for people living in SSA.

In 2014, Kenya's population was estimated at 44.86 million. With a growth rate of about 2.7% per annum and a majority young population, this was projected to grow up to an estimated 85 million by 2050 (World Bank, 2014). Kenya has the fastest growing economy in Eastern Africa (World Bank, 2015). In 2015, Kenya's economic performance was more than the average growth for Sub-Saharan Africa countries. The country's sustained economic growth in the past decade can be attributed to structural and economic reforms as well as infrastructural investments (World Bank, 2015). Even further, the World Bank projected a rise to 5.9% in 2016 and 6.1 % in 2017 (World Bank, 2016).

Improved living standards and diversified access to services have led to increased food availability. In urban areas such as Nairobi, there is a massive penetration of super- and mega-markets as well as large convenience store chains. The open (farmers) markets are declining as the major source of food; which is synonymous to the rest of the developing world (Popkin et al., 2012). These markets are increasingly being replaced by large international supermarkets such as Carrefour® and domestic chain stores (like Nakumatt®) which function and look like the global chains. A study by (Raschke & Cheema, 2008) indicated that these stores as well as fast food eateries have significantly changed food consumption and expenditure patterns of Kenyans from traditional (majorly plant-based) foods including sorghum, sweet potatoes, fruit and vegetables to increased consumption of energy-dense diets high in fat, particularly saturated fat, and processed carbohydrates.

Young people especially, fall into this trap of poor eating habits more often since these stores and fast-food restaurants are found in shopping malls and shopping centres and near their schools and places where they like to gather and socialize (Arat, 2016). In addition, tastes and preferences for these foods are acquired early in life and are difficult to change (Kigaru et al., 2015). The findings of (Kigaru et al., 2015) are consistent with those of (French et al., 2001) who observed that readymade packaged foods and high sweetened beverages are more convenient and preferred by young people. These foods are high in calories and fat and increase the susceptibility of young people to 'obesogenic environments' and incline towards unhealthy habits as described by (Poobalan & Aucott, 2016). The problem is worsened by availability of few healthier alternatives for snacks and food items; and the healthier options are sometimes unaffordable for young people (Kinyua, 2013).

Psychosocial stress during young adulthood, which is a period of transition from adolescence to adulthood may also lead to energy imbalances which can result in overweight and obesity (Poobalan & Aucott, 2016). In spite of youth being the key drivers of economic growth, few of them are beneficiaries. This maybe as a result of economic restructuring and transformation of labour markets which have caused decline in employment opportunities for youth (Gough et al., 2013). Some youth gain formal employment in areas such as IT and service industries, but most have to create jobs for themselves and rates of unemployment are high (World Bank, 2013). Majority of young Kenyans are stuck in unemployment or low productivity jobs, since the economic growth model limits the creation of quality jobs (Kiringai et al., 2016). According to (Gough et al., 2013) though not completely proven, unemployment and idleness lead to feelings of frustration among young people, which in turn may result in risky behavior such as drug and alcohol abuse as well as criminal activity. In addition, smoking and alcohol abuse, which may be acquired as coping mechanisms are combined risk factors for non-communicable diseases which are increasingly affecting the youth in SSA (Matheka et al., 2013).

Another factor that may be contributing to overweight and obesity in young adulthood is poor birth outcomes. Kenya, like other developing countries in SSA has high levels of poor birth outcomes such as low birth weight and stunting due to inadequate maternal nutrition (Norris et al., 2014). Studies indicate that socioeconomic improvement in developing countries has a direct link to rapid post-natal weight gain which contributes to higher BMI in young adults as they grow up in developing world settings (Nazmi et al., 2010). In addition, youth in Kenya are increasingly accessing college education (Sifuna, 2007). This makes them vulnerable to overweight and obesity (Anderson et al.,

2003). According to the KDHS, (2014) the prevalence of overweight and obesity increased with higher education levels and socioeconomic status.

Finally, another factor that may influence young people's weight gain is perceptions of body weight influenced by culture and social norms. In developed countries body thinness is associated with being beautiful, attractive and elegant and being in control (Metcalf et al., 2000). However, in most African culture, fatness is associated beauty, prosperity and good health, while thinness is associated with poverty and disease (Holdsworth et al., 2004).

Changes in dietary and lifestyle patterns have led to increased prevalence of chronic NCDs including overweight and obesity, diabetes mellitus, cardiovascular disease (CVD) and some types of cancer. These are increasingly becoming significant causes of poor health outcomes like disability and premature death in Kenya, placing additional burdens on already overtaxed national health budgets (Mwai & Muriithi, 2016). Interventions to help influence behaviour change among young adults towards adoption of healthy lifestyles are needed to help prevent more suffering and reverse the trend of NCDs in Kenya.

### 2.4 Diet Quality

Diet quality is a broad term frequently used to describe how well an individual's diet conforms to dietary recommendations. "It is an open-textured notion with no single static definition" which may include: healthy; balanced and nutritious diet, food nutrient values, meal portions, eating habits, and food variety (Alkerwi, 2014). A healthy diet supplies the appropriate nutrients in optimal levels of to maintain a healthy body. Similarly, a high-quality diet is one that is safe; able to promote optimal growth and development, and help in prevention of diseases (WHO Fact Sheets, 2015). Youth

diet quality, just like other population groups is influenced by factors such as their environment, socioeconomic status, level of education, culture and personal behaviours and attitudes toward food (Deshpande et al., 2009). A nutritious, high-quality diet is paramount in any weight loss routine, because according to (Scholtz, 2016) a person can lose weight by consuming fewer calories than they need for energy, but if attention is not paid to the nutrition content of their diet, they can end up being malnourished.

Information on diet can be collected and diet quality determined in many different ways. Food diaries and 24-hour recalls are commonly used in small studies and for short time frames. Larger studies and those with retrospective designs mostly use food frequency questionnaires. Food Diaries involve participants keeping a record of all food and drink consumed, together with their portion sizes on a daily basis. The 24-Hour Dietary Recall method on the other hand uses in-depth interviews where respondents are required to report all food and beverages consumed in the preceding 24 hours or over the previous day. Food Frequency Questionnaires are closed self-administered questionnaires comprising a food list and a frequency response section which is used to collect data on food items, portion sizes and frequency of consumption by respondents (Lovegrove et al., 2015).

Indices and surveys are generally used for quantifying quality of dietary intake. The most common indices used include the Healthy Eating Index (HEI), the Healthy Diet Indicator (HDI), the Healthy Food Index (HFI), the Diet Quality Index (DQI), the Diet Quality Score (DQS), the Recommended Food Score (RFS), and the Mediterranean Diet Score (MDS) (Wirt & Collins, 2009).These score diet patterns with regards to key dietary recommendations and the diversity of healthy choices within core food groups. The most commonly used index; the HEI was developed by the US department of

Agriculture (Kennedy et al., 1995). The index scores diet quality based on twelve dietary components: 9 “adequacy” and 3 “moderation”. Adequacy components include total fruits, total fruit, total vegetables, whole grains, dairy, and seafood and plant proteins. The moderation components are refined grains, sodium, and empty calories. The instrument has been found to positively correlate with nutrient intake. However, it is complex and requires quantitative estimation of nutrients and food groups (Kant, 1996).

Kinyua, (2013) used a semi-structured questionnaire to gather information on nutritional knowledge, nutritional attitude and dietary practices of female undergraduate students in Nairobi Central Business District (CBD). Data on dietary practices was collected on number of meals consumed daily, snacking habits, sources of meals consumed while in college, alcohol consumption and weekly food frequency consumption of nine food groups among 8 to12 recommended by the WHO. The evaluation for the number of meals consumed in a day was based on (5-6) times as recommended by (WHO, 2002). The mean number of meals consumed by the students was found to be 2.5 (SD 0.7). This is far below the WHO recommended number of meals per day. The meal with the highest priority was dinner as this was consumed by 76.3% of the students. About 40% of the students skipped breakfast; which had the least priority among the three major meals of the day. Snacking levels were quite low. However when they snacked, most of the students (41%) preferred unhealthy snacks made from highly refined cereals and those high in fat, salt and sugar. These findings were consistent with Aballa, (2013) and Kigaru et al., (2015)’s findings. The largest proportion of them (34%) preferred to eat in fast-food eateries. The daily consumption of fruits and vegetables was also found to be low. In spite of some level of nutritional knowledge, this did not translate to practice. There was no significant

association between nutrition knowledge and nutrition status (r = 0.032, P = 0.549). This may be as a result of difficulty with behaviour modification due to psychosocial or environmental factors. Therefore the researcher recommended enhanced practical nutrition education among university students as well as peer-based and environmental support strategies to help students realize the benefits of long-term healthy dietary practices.

The Rapid Eating and Activity Assessment Participants Short Version (REAP-S) is another tool that can be used to assess diet quality. It includes 16 questions to assess intake of whole grains, dairy, fruits and vegetables, saturated fat, cholesterol, sugary beverages and foods, sodium, alcoholic beverages as well as physical activity (Gans et al., 2003). It also includes questions on whether the interviewee shops and prepares their own food; whether they have trouble shopping or cooking; whether they follow a special diet; whether they eat or limit certain foods for health or other reasons; and how willing they are to make changes to eat healthier. In comparison with the HEI, REAP-S is very simple. Moreover, feasibility and validation studies as well as cognitive assessments have been carried out with it and has been found to be reliable, efficient and valid (Segal-Isaacson et al., 2004). REAP-S also has excellent reliability scores and correlates well with the Healthy Eating Index scores (Gans et al., 2006). However, one possible shortcoming of the REAP-S is its inability to approximate a subject's meat intake (Scholtz, 2016).

Sholtz, (2016) used the REAP-S questionnaire to collect dietary information and score the diet quality of participants in a Smartphone app interventional study to promote weight loss, improve diet quality and diet adherence. There was no mean difference in diet quality (REAP-S; P=0.053) between the diet quality of the participants in the

experimental app group and those in the control app group. However, although the Smartphone app under study was not found to be superior to the control app in improving diet quality, both apps were found to help the participants adhere to healthful diets. The researcher recommended that diet apps need not be complex in their design but simple enough to enable users adhere to their diet plans for weight loss and healthy weight maintenance.

### 2.5 Physical Activity

Physical activity (PA) refers to any body movement by skeletal muscles which results in energy expenditure; which can be measured in kilocalories (Caspersen et al., 1985). Daily physical activity can be categorized into occupational, sports, conditioning, household, or other activities. Physical activity is a significant determinant of nutritional as well as health status (WHO, 2002). Modernization and improved living standards have led to behavioural transitions into more sedentary lifestyles, which in turn have resulted into increased proportions of overweight and obese children in Africa (Muthuri et al., 2014). Exercise is needed to lose weight and increasing PA is an essential component of any treatment plan for obese individuals and confers numerous cardiovascular benefits (Haskell et al., 2007).

Methods used to collect data and determine levels of physical activity include: doubly-labelled water method (DLW), self-report questionnaires, self-report diaries, direct observation and wearable devices. Self-Report Questionnaires are the most common method of assessing physical activity and rely on participants' ability to recall (van der Ploeg et al., 2010). They are used to report mode, duration, or frequency of PA in terms of activity scores, time and calories. Their advantage is that they are cost effective, they are easy to administer, and are somewhat accurate in measuring intense PA (Besson et

al., 2010). However, validity studies comparing self-report questionnaires to the DLW; which is the gold standard for assessing total energy expenditure, show inconsistencies (Westerterp, 2009).

Pre-tested and validated questionnaires such as the International Physical Activity Questionnaire (IPAQ) can be used to estimate physical activity. The IPAQ was developed by an international Consensus Group in order to solve the problem of lack of a standardized approach to measuring physical activity with the ability to make international comparisons and global surveillance possible (Karolinska Institute, 2002). The questionnaire has four (two short and two long) versions which can be self-administered or administered via telephone interview. The IPAQ can be used to assess physical activity undertaken across four domains including: leisure time physical activity, domestic and gardening activities, work-related physical activity and transport-related physical activity. The short version asks about three specific types of activity undertaken in the four domains; walking, moderate-intensity activities and vigorous-intensity activities. Each one of these activities gives separate scores that can be used to compute the total physical activity undertaken. The total physical activity can be represented categorically (as low, moderate or high) physical activity or continuously as median MET minutes/week. A MET is a multiple of estimated resting energy expenditure. One MET is energy expended at rest, while walking to be 3.3 METS, moderate physical activity to be 4 METS and vigorous physical activity to be 8 METS. A high score of physical activity on the IPAQ means one engages in vigorous intensity activity on at least 3 days, achieving at least 1500 MET minutes a week, or has 7 days a combination of walking, moderate intensity or vigorous intensity activities achieving at least 3000 MET minutes a week. Scoring a moderate level means one is doing some activity, likely equivalent to half an hour of at least moderate intensity physical activity

on most days, or 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum total physical activity of 600 MET minutes a week. A low level score of physical activity means one is not meeting any of the criteria for either moderate or high levels of physical activity.

Craig et al., (2003) assed the long and short versions of the questionnaire for validity and reliability in assessing physical activity over 12 countries and found no difference was found in reliability and validity of the long and short forms. The short version was recommended for single region studies while the long was recommended for studies requiring details on the dimensions of the physical activity.

Self-Report Activity Diaries is another method in which participants record physical activity in real time giving details (van der Ploeg et al., 2010).The method is better than questionnaires as it is less susceptible to recall errors. Direct observation method involves an independent observer monitoring and records physical activity in a restricted space such as classroom (Sleap & Warburton, 1996). The disadvantage is that it is a time consuming method and is expensive. Devices such as accelerometers, pedometers and heart-rate monitors can also be used to monitor physical activity. They are especially useful in studies where participants have difficulty self-reporting such as studies involving children. However they can be expensive to use in large scale studies (Sylvia et al., 2014).

### 2.6 Nutritional Status

Nutritional status is the state of the body with regards to the level of nutrients and their ability to support normal metabolic functions in the body; and is a consequence of food intake, food quality and quantity and physical health. Good nutrition results in overall improvement in nutritional status; which is important for people to stay alive, move and

work; build new cells and tissues for growth, maintenance and repair; resist and fight infections and avert non-communicable diseases (WHO Fact Sheets, 2015). Poor nutritional status is the greatest obstacle to the fulfilment of human potential (United Nations Standing Committee on Nutrition, 2009).

Biological, ecological and behavioural methods are often used to assess nutritional status. Biological indices include biochemical laboratory tests as well as clinical observation for manifestation of malnutrition. Ecological indicators are those related to dietary intake, the environment and anthropometry; while behavioural indices use surveillance systems to monitor the impact of nutrition interventions (Jeejeebhoy et al., 1990).

Anthropometric measurements such as BMI and Waist Circumference are most commonly used to diagnose over-nutrition (overweight and obesity) since they are commonly applicable, non-invasive, simple and inexpensive (WHO, 1995). BMI is a person's weight in kilograms divided by the square of his height in meters ($kg/m^2$) and is commonly used to classify overweight and obesity in adults. Overweight is a BMI greater than or equal to 25; while obesity is a BMI greater than or equal to 30 (WHO Fact Sheets, 2016). The accuracy of using BMI for diagnosing obesity is however limited especially among the elderly and men (Romero-Corral et al., 2008). In addition, and inconsistencies in classifications of risk of metabolic syndrome using the WHO cut-offs have been observed in different populations due to use of data from limited populations in determining the cut-offs (Seidell et al., 2001).

Waist circumference (WC) is also used to identify obesity-related morbidity risk due to accumulated abdominal fat (WHO, 2002). The measurement is taken at the approximate mid-point between the lower margin of the last tangible rib and the top of the iliac crest.

The tape should be fitted on the body but not too constricting (WHO Expert Consultation, 2008). The criteria for selection of cut-off points of waist circumference is men (WC≥94 cm), women (WC≥80cm) for at risk and men (WC≥102cm), women (WC≥88cm) at high risk. The key problem with using waist circumference to determine body fatness using cut-offs from populations from developed countries is that there are systematic differences in the extent to which given waist circumference levels predict disease outcomes in different ethnic groups. Such differences could lead to underestimation of risk in certain populations (Misra et al., 2005). However, WC is a validated predictor of metabolic syndrome, especially in populations with predisposition to central (abdominal or visceral) obesity such as those in Asia and Africa. The WHO recommends using waist circumference to refine interventions based on BMI (WHO Expert Consultation, 2008).

Studies carried out in the Kenyan context involving youth also used BMI and WC to measure nutritional status. Kinyua, (2013) used BMI measurements to determine the nutritional status of female undergraduate students aged 19 to 25 years in Nairobi CBD. The prevalence of overweight and obesity among this population was found to be 22.9%. In another study involving adolescents (aged 9-11 years), Muthuri et al., (2014) used BMI as well as waist circumference measurements; which were made on exposed skin at the end of a normal expiration using a non-elastic anthropometric tape midway between the lower rib margin and the iliac crest to assess nutritional status. 14.4% of the study participants were found overweight, and 6.4% were obese based on WHO cut-points of WC. The two studies sited poor eating habits and sedentary lifestyles among the youth as causes for poor health outcomes.

## 2.7 Interventions Used in Prevention and Management of Overweight, Obesity and Non-Communicable Diseases

The need for action to strengthen control and prevention measures to counter the spread of the NCDs epidemic is now widely recognized by many countries. Although, developing countries are lagging behind in implementing such measures, efforts to counteract the rise in chronic diseases are increasingly being assigned a higher priority. This is evident in their growing interest in addressing food and nutrition policy, health promotion, and strategy for the control and prevention of chronic diseases, as well as other related topics such as promoting healthy ageing and tobacco control. During the 2012 World Health Assembly, member states adopted a 2011 Political Declaration to reduce premature non-communicable disease mortality by 25% in 2025, hence creating the 25 by 25 Target (Santosa, Rocklöv, Högberg, & Byass, 2015).

Obesity and overweight reflect energy imbalance, so the major areas for intervention relate to dietary intake and physical activity to increase energy expenditure (Barry M. Popkin et al., 2012). Public health interventions target multiple risk determinants which are both behavioural and biological risk factors to prevent or reduce the NCD risk. To date, many weight loss interventions have been attempted, including dieting, the use of medications, different technologies, and surgeries (Scholtz, 2016).

In India, policy interventions related to tobacco control, alcohol reduction, production and supply of healthy foods, regulation of unhealthy foods, and urban planning which promotes physical activity have been used and found to be effective. In addition, community empowerment through health promotion programs has enhanced knowledge and skills which in turn have fostered awareness and adoption of healthy behaviours (Singh, Reddy, & Prabhakaran, 2011).

Data on interventional studies targeting overweight and obesity in Kenya is limited. However, the Kenyan government has prioritized NCDs prevention and control in its National Medium Term Plan (MTPII) 2014-2018; National Health Strategic Plan (KNSSP) 2014-2018; the United Nations Development Assisted Framework (UNDAF) 2014-2018 for Kenya; and the Kenya third generation WHO Country Cooperation Strategy (2014-2019) (WHO, 2014). The Government of Kenya needs support in its efforts to curtail the heavy double burden of malnutrition in implementing the wider national policy framework outlined in the 'Kenya Vision 2030', which aims to ensure a high quality of life for its people.

Various factors hinder the sustainability of Public Health interventions in sub-Sahara Africa. These include: weak health systems, healthcare worker shortage and lack of awareness and education regarding the health issues (Iwelunmor et al., 2016). In a study to estimate the prevalence and awareness rates of hypertension in Africa, Adeloye & Basquill, (2014) found that despite the high prevalence of hypertension in Africa, awareness of the disease, though increasing, still remains low. They recommended that policy makers and stakeholders in the health sector institute nationwide population-based strategies towards creating awareness on hypertension and educating people on the main risk factors such as smoking, harmful use of alcohol, sedentary lifestyles and unhealthy diets.

## 2.8 The Use of Mobile Health Technology in Prevention and Management of Overweight Obesity and Non-Communicable Diseases

It is paramount for interventions promoting healthy lifestyles to be tailored specifically for the youth since, not only are they currently affected by NCDs, but will also experience the long-term repercussions of the current NCD policy implementations

(Matheka et al., 2013). One way of delivering these interventions is through the use of m-health technology since the use of mobile phones use among populations in developing countries has increased and will soon reach saturation (Kaplan, 2006). Moreover youth spend most of their leisure time on their mobile phone devices playing games, watching videos and communicating with each other via social media (Wanjiru, 2010). Through mobile phone apps, nutrition counselling can be more accessible; and will no longer be relegated to the health centre. These apps may be a useful and cost-effective resource for youth who are increasingly being required to follow certain dietary recommendations due to poor nutritionally-related health outcomes. To date, there are many health related and more particularly, diet related applications that are available for free download and use. These apps rely on conventional methods often used by nutritionists such as food diaries; where clients record daily food intake since when one remembers what they eat they are more likely to be successful in following diet advice. Apps are superior to the traditional pen and paper method of food diaries. This is because they provide a simple and convenient way of making the daily food records. In addition, they offer the confidentiality that the conventional method does not offer, and are flexible to use as they do not require carrying extra baggage of notebooks and pens (Casperson et al., 2015).

Although Kaplan, (2006) found little evidence concerning effective use of m-Health solutions in developing countries, mobile phone interventions have been shown to have the potential to deliver desirable health outcomes. For instance, one of the most popular apps, MyFitnessPal® underwent a four-week trial to determine if it could be used to reduce sodium intake to $\leq$ 2,300 mg/day compared to the traditional diary method. There was a significant difference in the mean urinary sodium change between the group that used the app and the group that did not use it from the start of the intervention

to the completion (-24.0±32.6 and 8.5±41.9 mmol/g creatinine respectively, p = 0.027). The MyFitnessPal app proved to be a useful tool in reducing and/or monitoring sodium intake (Ipjian, 2016). Thus, this trial reinforces the potential of Smartphone apps to be used for monitoring sodium and intake of other nutrients. In another recent study to find out the effectiveness of an m-Health intervention in managing pre-hypertension, although the m-Health-based intervention did not result in a change in blood pressure; that significantly differed from that of the control group (who received the usual care), it was associated with a small reduction in bodyweight and an improvement in some diet quality (Rubinstein et al., 2016).

From an economic viewpoint, mobile phones are more cost effective due to their scalability. Functionally, mobile phones use requires no special skills and can be rolled out faster and over large areas thereby increasing accessibility to healthcare (Kaplan, 2006). Moreover, using Smartphone applications can improve attitude towards physical activity. For example, in a study correlating use of apps and changes in physical activity, health and lifestyle behaviour, and self-image of short and long distance runners, app use in 16 km runners was found to be positively related to feeling more energetic, eating healthier and maintaining the sport behaviour (Dallinga et al., 2015).

The effectiveness of m-Health interventions in delivering lifestyle change outcomes depends on use of behaviour change techniques to influence behaviour change (Dallinga et al., 2015). However, most of the commercially available diet-related applications do not incorporate behaviour change techniques. Therefore they do not create lasting change in users. Dallinga et al., (2015) further suggested that app developers need to invest in providing content and employing change techniques known

to be effective in changing relevant behaviour patterns in order to improve the user experience and foster behaviour change. Behaviour change techniques such as goal setting, self-monitoring and provision of feedback were the most frequently identified types of change techniques in Smartphone applications analysed by (Bardus et al., 2016). Bardus et al., (2016) found that the quality of applications was positively correlated with number of behaviour change techniques included (rho = .58, $p < .01$) and the number of technical features (rho = .48, $p < .05$), which was also associated with the number of behaviour change techniques included (rho = .61, $p < .01$). Additionally, applications that provided tracking used significantly more techniques than those that used change techniques were associated with effectiveness and had better information quality. These techniques are the most consistent with literature on weight management interventions generally (Hutchesson et al., 2014). Finally, for m-Health interventions to be effective in lifestyle modification especially among youth, they need to provide for social interaction such as through social media (Svetkey et al., 2015). This provides the social support needed by users to help sustain behaviour change.

## 2.9 The Superfit App

The Superfit App was custom-developed for this study based on the Dietary Approaches to Stop Hypertension (DASH) recommendations for healthy lifestyles (National Heart, Lung, and Blood Institute, 2014). The DASH diet plan has core guidelines for consumption of vegetables, fruits, grains, protein, fats and oils, sweets, nuts and low-fat dairy. The recommendations encouraged participants to eat a variety of its eight food groups and set upper intake limits on all the food groups. In addition, participants were encouraged to do moderate intensity exercises for 30 minutes at least four times a week.

The DASH recommendations were appropriate as a guide for the application because their simplicity, making it easy to adhere to. According to Svetkey et al., (2015), behaviour change interventions that are simple have a better adherence rate than those that don't. Adherence is a key factor in sustained weight loss (Scholtz, 2016). Successful weight loss and healthy weight maintenance relies on individual commitment to follow given diet and physical activity guidelines consistently.

In addition, the DASH eating plan promotes balanced diet. Most diet-related apps that were found on the internet relied on counting calories to promote weight loss, without paying attention to the actual foods consumed. The Superfit app on the other hand, was based on the DASH recommendations. Therefore, it emphasized on a varied and high quality diet; hence overall healthful eating, promoting weight loss and good health. (Reedy et al., 2014) demonstrated that following a DASH eating plan recommendations was associated with a lower risk of CVD and cancer mortality outcomes for both men and women. In addition, they found that although DASH recommendations did not emphasize specific nutrients or foods as protective against CVD and cancer, the research provided evidence regarding the benefit of an overall healthy eating pattern with whole grains, vegetables, fruit, and plant-based proteins.

The Superfit App had the following features based on behaviour change techniques; goal setting, self-monitoring, social support, provision of information about behavioural outcomes, increasing skills and providing feedback about performance (Abraham & Michie, 2008). These strategies have been found to effectively promote health-related behaviour change (Webb et al., 2010).

The study participants accessed the app by logging onto the website (www.superfitapp.co.ke ). They registered by creating an account using their emails

and secured it by a password. After registration, users were required to enter information on their weight, height and waist circumference. The weight and height data generated their BMI which was tabulated on a graph chart. The graph chart showed progress made, each time new data on weight measurements was entered. Users also were prompted to input their goal weight. Finally, users recorded their food intake and physical activity on a daily basis; which was also shown using charts. The data was achieved on a daily basis, and used to generate weekly consumption and exercise patterns. Participants could chat with each other using text in order to support each other during the process. The website was publicly accessible to anyone; however, participants were advised not to share the information during the stud. The server was monitored to prevent registration of non-study participants.

### 2.10 Conceptual Framework

Applications that run on Smartphone devices improve the quality of life for users by increasing convenience of access to information and getting tasks completed. This study used a Smartphone web app that was designed for health information and was used to influence health behaviour. Figure 2.1 below is a schematic diagram showing the conceptual framework for this study which was adapted and modified from the PRECEDE-PROCEDE model developed by (Green, L.W. et al., 1980). In the model, the PRECEDE component involves assessing the behavioural, social, educational, epidemiological, environmental, and ecological factors which inform the development of an intervention while the PROCEED component concerns pilot-testing and evaluating the implementation of the intervention, its impact on intermediate factors and outcomes of the population under study.

The goal of this study was to validate the use of a new Smartphone web app in improving diet quality, physical activity and consequently weight-loss. The use of the web application was the intervention (also the independent variable) which was perceived to influence two intermediate variables; diet quality and physical activity. When both diet quality (measured using a REAP-S score) and physical activity (measured using the IPAQ) improve, it was anticipated that the weight status (measured in BMI and waist circumference) would improve.

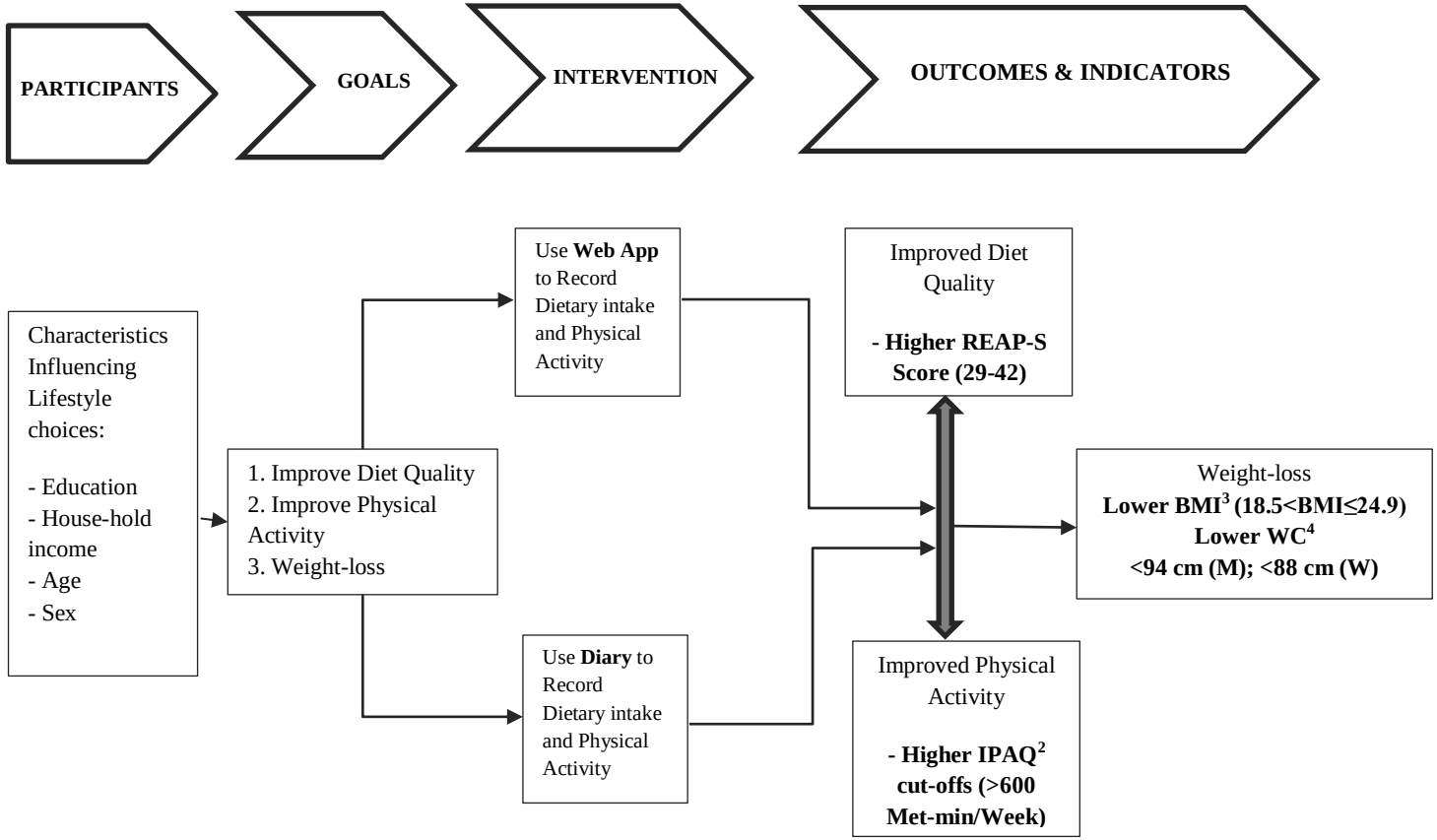


**Figure 2.1: Conceptual Framework**

## 2.11 Summary

The problem of overweight, obesity and NCDs is no longer a First World concern, but is steadily catching up with developing countries such as Kenya due to changing lifestyles (Poobalan & Aucott, 2016). There is need to address this challenge using state of the art technologies targeting positive lifestyle change; because of its overwhelming impact on health systems, economies and quality of life of people in these countries. Young adulthood seems to be the opportune time to introduce interventions to address lifestyle change before lifelong behaviours set in (Naik & Kaneda, 2015). Various interventions including policy, health promotion and reactive interventions like dieting and medications have been used in the past. According to Svetkey et al., (2015) young people need interventions that augur well with them; such as m-health technology, which is a growing area in the fight against overweight obesity and NCDs. These m-health technologies however need to be based on sound research and scientific knowledge in order to influence appropriate and lasting change.

There are few m-health related interventional studies for overweight and obesity in Kenya. Most studies reviewed were prevalence studies showing the extent of the problem. In addition, there is limited evidence on the spectrum of problem among young adults as most of the studies focused on school going children. The statistics however, showed significant increase in overweight and obesity; which needs to be addressed. This study sought to address the gap concerning the limited use of m-health in addressing the problem of overweight and obesity among youth (aged 18 to 35 years) in Kenya.

# CHAPTER THREE:

# METHODOLOGY

## 3.1 Introduction

The purpose of this research was to evaluate the use of a Smartphone web application in improving diet quality, physical activity and nutritional status of a sample of youth from Nairobi County. The study used an institution-based randomized controlled trial design to compare the web app to the traditional diary method. Outcomes included diet quality, physical activity and nutrition status (measured by BMI and waist circumference). The study recruited 74 participants from 5 institutions of higher learning in Nairobi's Lang'ata Sub-county. This section describes the methodologies used in the study; including criteria for selection of study sites, recruitment of participants, randomization, follow-up, data collection and analysis.

## 3.2 Study Area

Nairobi is the capital and largest city in Kenya. With a population of 3,138,369 according to the Kenya Bureau of Statistics, (2009) and an area of 694.9$Km^2$, the population density of Nairobi was 4,516.29 people per square kilometre. Nairobi has one of the highest rates of urbanization in Africa. By the end of 2012, population had increased to 3,517,334 people with an average density of 5060 persons per $Km^2$. By the end of 2017, the population density was set to rise to 6119 persons per $Km^2$ (United Nations Human Settlements Programme, 2009).

Nairobi is a key business and trade hub in East and central Africa, and the regional location of and headquarters for various international companies and organizations. Many of Kenya's big businesses, commercial institutions as well as the central government are located in Nairobi. Since this study was targeting youth, Nairobi was

the most appropriate location since it has the largest proportion of youth living in it compared to other parts of the country. 34.1% of people residing in Nairobi in were youth aged 19 – 35, compared to 18.9% of those living in other areas of the country (KDHS 2008).

Nairobi is also a metropolitan city and thus has the most appropriate representation of the various socio-cultural backgrounds of Kenya. It is also a centre for tertiary education as numerous Institutions of Higher Learning (IHL); including colleges and universities have mushroomed to cater for the career development needs of the young professionals in Nairobi.

**STUDY AREA – NAIROBI COUNTY**

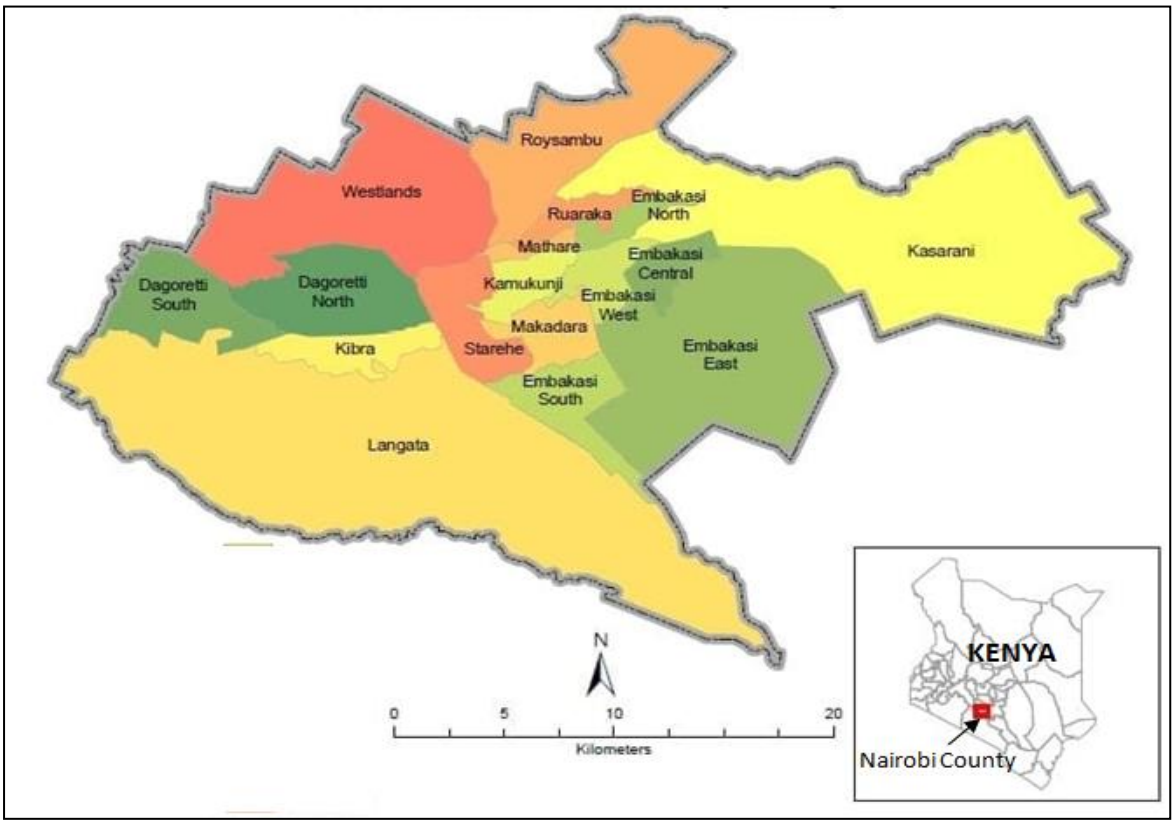


**Figure 3.1:** Map of Nairobi County; Showing the different Sub-counties. Source: (Liza & Mwaura, 2016)

Lang'ata is one of Nairobi's 17 Sub-counties with an area of approximately 106km$^2$. Lan'gata had a population of 355,188 in 2009 which translated to a population density of approximately 3,346 persons/km$^2$ (KNBS, 2009).

Nairobi's Lan'gata Sub-County was ideal for this study since it is close to the city centre and the effects of urbanization on diets, physical activity and nutritional status are prominent. Lang'ata was selected for purposes of this study because it is a mixed residential area; with middle class residential estates including Otiende, Ngei, Onyonka, Nairobi Dam, Madaraka, South 'C', Nyayo Highrise, Southlands and Jonathan Ngeno among others; for people who work mainly in the City of Nairobi (Liza & Mwaura, 2016). The area is also associated with the Kibera Slums; one of the largest in Africa, which hosts a huge population of low economic status. Finally, Langata is characterized by the high-class Karen zone; associated with low-density single, family homes for the wealthy. This area hosts quite a number of universities and colleges attended by students who live in the area and a majority who come from surrounding areas, making the zone appropriate for this study.

**STUDY LOCATION – LANG'ATA SUBCOUNTY**

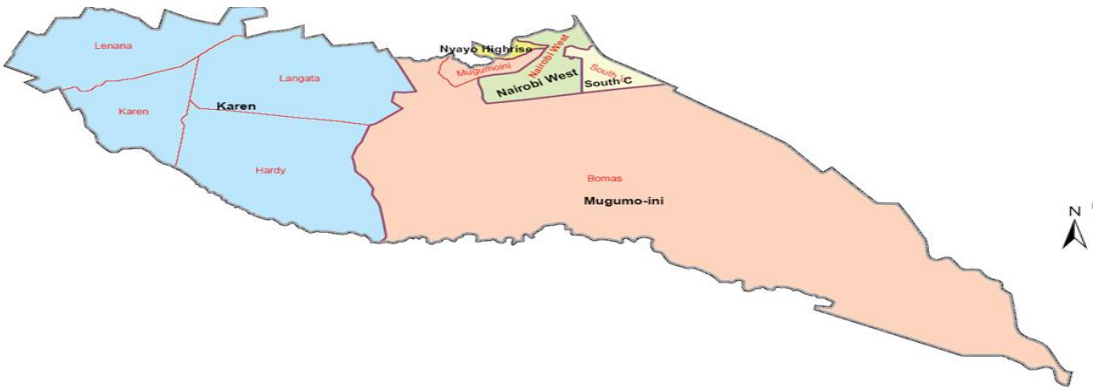


**Figure 3.2:** Administrative Units of Lan'gata Sub-County. Source: ("Langata Constituency," 2011)

### 3.3 Target Population

The target population for this study was youth aged between 18 and 35 years living in Nairobi County. Youth aged 9 to 35 comprise a majority (about 35%) of Nairobi's population. Not only are these individuals currently experiencing chronic, non-communicable diseases (NCDs), they are either living with or at risk for these conditions, but will also experience the long-term repercussions of NCDs (Matheka et al., 2013).

According to the KDHS, (2014), for women of reproductive age (15-45) obesity was more prevalent among urban residents (43.5%) than among rural residents (26.0%). Several studies carried out in Nairobi indicate that the prevalence of obesity and NCDs is quite high among young people. For instance, a study carried out by Kimani-Murage et al., (2015) in a slum in Nairobi found that the proportion of overweight and obesity among younger adults (18 to 29 years) was 17.1%. Another study by Joshi et al., (2014) in Kibera slum in Nairobi where subjects had a mean age of 33.4 years, found the age-standardised prevalence of hypertension (95% CI) to be 22.8% (20.7, 24.9). Among this group, 5% reported that they had diabetes.

### 3.4 Study Population

The study population comprised youth (male and female between 18 and 35 years) attending both public and private universities and colleges within the Karen ward in Nairobi's Langata Sub-county; with a BMI greater than 24.9 Kg $m^{-2}$; and owners of web-enabled Smartphone. Participants were both undergraduate and graduate students, who were in a position to make decisions on the food they consumed.

The reduced/subsidized cost of Primary and secondary school education has resulted in increased enrolment at institutions of higher learning in Kenya. According to statistics from the Ministry of Education, by the end of 2013 276,349 students had been enrolled to public universities; a 41% increase from the previous year. On the other hand, admissions to private universities were at 48,211 in 2013 (a 7.1% increase). These statistics are relevant because the highest level of education attained by has been linked to prevalence of obesity among Kenyans (KDHS, 2014). There are limited data showing the proportions of school going young adults affected by obesity. Available data however show worrying trends with the prevalence of overweight and obesity among school going children. According to Steyn & Damasceno, (2006) the prevalence of overweight and obesity among school aged children was at 17.4% and 6.2% respectively.

## 3.5 Study Design

This study adopted a randomized controlled trial (RCT) design. It was also institution-based with participants from higher learning institutions. After recruitment and randomization into the treatment groups, baseline data was collected on characteristics including diet quality, physical activity levels, BMI and waist circumference; and further data collection at the end of six and twelve weeks after the study begun.

## 3.6 Study Protocol and Procedures

### 3.6.1 Enrolment

In this institution-based trial, potential participants were sought after through flyers on notice boards, word of mouth and social media. Those who registered their interest by communicating through phone calls or text messages were referred to a Google Forms Questionnaire (Appendix IV); which conducted the initial screening on health status and other personal details.

### 3.6.2 Recruitment and Randomization

Eligible participant pool was reviewed using inclusion and exclusion criteria. Those qualified were recruited into the study while those who failed to meet the inclusion criteria were notified. The qualified participants were then assigned number values. Ultimately, they were placed randomly into either the experimental or control group; by tossing a virtual coin using an online computer program (RANDOM.ORG ).

Research assistants were enlisted and given a brief overview of the study. Afterwards, they were trained on the diet and physical activity recommendations based on the DASH guidelines. Finally, they were trained on appropriate ways of taking anthropometric measurements and administering the questionnaires.

Subjects were notified by text messages about their selection to participate in the study. They were scheduled to meet to meet with the research assistants individually for the first visit in their school's clinic (week 1), each participant's visit lasting approximately 15 minutes. First, the subject was given a general overview of the study as well as estimated time commitments. After that, they were asked to sign the consent form (Appendix V). Subjects were then given a survey comprising questions from the REAP-S (Appendix VII) questionnaire as well as the IPAQ (Appendix VII). Their weight, height and waist circumference measurements were also taken and recorded to the nearest 0.1unit.

Finally using pamphlets (Appendix VIII) for counselling, participants were given a diet and exercise protocol which they were supposed to adhere to. The dietary protocol; based on the DASH guidelines involved participants consuming: 7-8 servings of whole grains, 4-5 servings of vegetables, 4-5 servings of fruits, 2-3 servings of low-fat or fat free dairy products, 2 or less servings of meat or poultry, 5-5 servings of nuts or seeds

and 2-3 servings of fats and oils daily. The physical activity protocol required that participants do moderate intensity exercise on at least 5 days a week or vigorous intensity exercise on at least 3 days a week. After the visit with research assistants, they met with the principal investigator and were given instructions on how to utilize either the app; for those in the experimental group or a diary (in form of a notebook); for those in the control group to record their food intake and exercise on a daily basis.

### 3.6.3 Intervention group

Participants were required to record their food intake and physical activity in the Superfit app after registering online. The process involved recording the actual food and number of servings in the corresponding food group category (i.e. protein, starch, fruit, vegetable, dairy, nuts and fat). For example, if a subject consumed 2 slices of bread and a cup of milk for breakfast this would entail logging into the Superfit website, entering a "2" in the starch text box, a "2" in the "Dairy" text box. For exercise, the subject was required to input the type of exercise, its intensity and duration. Finally, after all entries the subject would click the "Save Changes" button. They would then be returned to the status page where progress showed their current status toward daily and weekly Superfit goals. These updates were made any time throughout the day and every day at 12:01 am the app automatically archived the previous day's data and presented a new, empty log screen.

### 3.6.4 Control group

Participants in the control group were required to follow the same diet and exercise recommendations as those followed by those in the intervention group. They however recorded their daily food intake and exercise activities in a diary (simple notebook).

### 3.6.5 Follow-up

After the initial visit, participants were required to record their daily food intakes as well as exercise routines using the intervention app over the course of 12 weeks either in the app or diary. No further contact was initiated with subjects until the fifth, and eleventh weeks when a reminder text message was sent to each subject to schedule the follow up visits on the sixth and twelfth weeks respectively. However, participants were free to contact the investigators when questions or concerns arise. At the end of the sixth and twelfth weeks the study subjects were assessed. During each time, they removed their shoes, socks and other overlay clothes prior to being weighed on a calibrated Omron® HN 289 scale (Omron Healthcare Co. Ltd., Kyoto, Japan). Height was not re-measured. A survey was also administered at the end of the twelfth week. The survey had dietary and physical activity questions identical to those administered during the first visit. Participants were also given an exit survey where they were asked to provide opinions of the app used, comments about the study, and any additional feedback they desired to share.

### 3.6.6 Blinding

Interaction among participants between groups was discouraged and they were not told which intervention was experimental or control. The principal investigator, who conducted the randomization of participants was not involved in the data collection. The research assistants taking the measurements and administering the questionnaires did not know which group the participants belonged to. Contamination was pre vented by regularly monitoring the Superfit app data base to ensure no new users registered during the study period. Additionally, participants using the app were discouraged from sharing information about the app.

## 3.7 Sampling

### 3.7.1 Sample Size Determination

The number or respondents to include in the study was estimated based on the Lehr's crude formula for sample size calculation. Since this experimental study is the first of its kind in the target population group (young adults aged 18-35) and the intervention is novel in nature, it was difficult to predict the expected outcomes. The aim therefore was to achieve moderate effects for comparison between the intervention (web application) and the control (food diary); in order for the intervention to be of practical relevance for use in public health.

Using statistical power, i.e. $Z_\beta = 0.80$, $\alpha$ level set at 0.05; the sample size (*N*) required for each of 2 treatment groups (intervention and control), assuming equal cell size to detect various effects was calculated as follows:

Sample size, $N = \frac{2(Z\alpha+Z\beta)^2}{d^2}$

$2(Z\alpha + Z\beta)^2 = 2(1.96 + 0.80)^2 \approx 16$

Therefore, $N = \frac{16}{d^2}$

Where *d* is the effect size (the measure of how big a difference that is needed to be dictated between the two treatment groups being compared). According to Watson P.'s classification of effect sizes, a Cohen's $d = 0.5$ is considered moderate and is therefore a clinically meaningful population effect size, for comparison of two groups on a continuous outcome.

Therefore: $N = \frac{16}{0.5^2}$

Which is = 64

This means that at least 64 respondents need to be included in each treatment group. The total sample size was therefore equal to 128.

According to Wittes and Brittain, (1990), sample size for a pilot trial should be at least 50%, of the main trial to confirm estimates of variance used to power main study. The study should be large enough to be confident in the variance estimates.

50% of 64 = 32. Which brings the final total sample size for the pilot trial to 64 participants.

### 3.7.2 Sampling Procedures

This study recruited young adults, with no known health condition deemed risky for the study, aged 18 to 35 years from 5 IHL within Langata County's Karen area. These included 5 universities (Catholic University of East Africa, Cooperative University of Kenya, Jomo Kenyatta University of Agriculture and Technology, Kenya Medical Training College of Nutrition and Tangaza College). Nairobi's Langata Area was chosen as a location for the study because of convenience in accessing the study sites. These study sites were also selected by convenience based on the administrations' acceptance for their students to participate in the study. Letters were sent to all the institutions of higher learning within the Karen Ward. The first 5 (about 30%) to respond were selected.

Once the study sites were identified, potential subjects were solicited using flyers and posters which were posted on campus notice boards for two weeks. Class to class presentations were also made and adverts placed on campus social media platforms to invite any interested potential participants. In addition, by snowballing effect, recruited participants were used to draw other probable volunteers. Interested parties were referred to a Google Forms questionnaire (Appendix IV) for them to fill and submit online. This form conducted initial health screening questions and collected contact information. Participants who met selection criteria were were randomly allocated into

either the experimental or control groups by coin toss using an online computer program (random.org) to assign the participants into respective intervention or control groups.

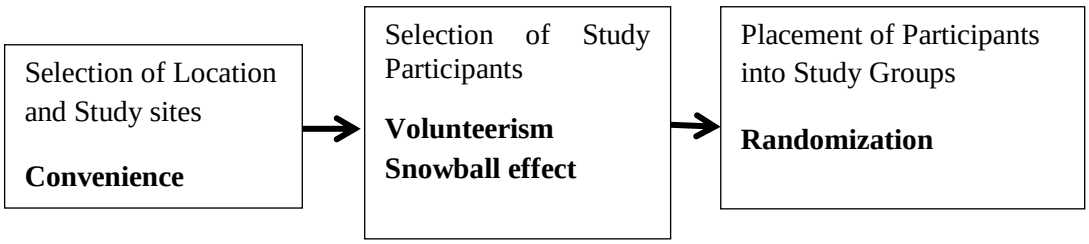


**Figure 0.3:** Flow Diagram of Sampling Procedures

### 3.7.3 Inclusion Criteria

Criteria for inclusion of subjects into the study were youth without any known health condition deemed risky for the study, ages 18-35, with a BMI >24.9; maximum BMI limit was not enforced. Participants will be required to be owners or users of a web-enabled Smartphone.

### 3.7.4 Exclusion Criteria

Participants who were excluded from the study were those with confirmed chronic conditions such as cancers, and other substantial health issues that seemed unsafe for the study. Subjects known to be taking long-term prescription medications such as antiretroviral therapy drugs (ARTs) and those used to treat mood disorders, seizures, hyperacidity, diabetes, hypertension as well as steroids and oral contraceptives were also excluded due to health safety issues. Other exclusion criteria were based on evidence that these factors negatively influence weight loss. These were; Persons revealing smoking, alcohol abuse or other illicit drugs were excluded. All types of eating disorders were excluded. Those with limited ability in choosing the food they consume such as those in assisted living hostels were excluded from the study. Females were asked about regular menstrual cycles and if they were planning to become

pregnant during the study. Those with irregular cycles or pregnancy plans and those breastfeeding were excluded. Finally, individuals who were competing athletes were excluded from the study

## 3.8. Study Variables

### 3.8.1 Dependent (Outcome) Variables

The main objective of this study was to examine the use Smartphone app in improving diet quality, physical activity and weight-loss. Therefore, diet quality, physical activity and weight-loss are the dependent variables.

Diet quality was measured using questions from the Rapid Eating Assessment for Patients short version (REAP-S) questionnaire, physical activity was assessed using the IPAQ; while weight-loss was measured in terms of BMI and waist circumference.

### 3.8.2 Independent Variable

Changes in the main outcomes of interest; diet quality, physical activity and weight-loss were dependent on the use of the intervention (either m-Health software or diary). Therefore, use of the intervention is the independent variable. This was measured in terms of number of days study participants used the app or diary.

### 3.8.3 Intervening Variables

Possible intervening variables may have included: age, gender, education level and household income. These variables had the ability to influence the frequency of use of the app and may have had affect diet quality, physical activity and ultimately nutritional status.

## 3.9 Data Collection Methods

### 3.9.1 Food Diaries

Study participants in the Superfit group kept a record of all food and drink consumed, together with their portion sizes on a daily basis using the application while the control group participants used the conventional paper and pen method to record the same. They were trained at baseline on the level of detail required to describe adequately the foods and portion sizes consumed as well as exercise they engage in. This data was obtained after 12 weeks.

### 3.9.2 Questionnaires

The REAP-S is a closed, self-administered questionnaire, which was used to collect data on diet quality. In the REAP-S survey, 14 Likert scale questions equate to a possible score range of 14 through 42. Survey responses were coded in a manner that assigned higher scores to healthier responses. Answering “usually/often” was assigned one point, “sometimes” two points and “rarely/never” as three points. Two questions regarding eating frequency and shopping habits are “yes” or “no” response was assigned 3 and 1 point respectively. A higher total score therefore indicated higher diet quality. Participants were characterized as having “poor”, “medium” and “high diet quality” if their score was “0-14”, “15-28” or “29-42” respectively.

The IPAQ short version was used to collect data on and assess physical activity. Three types of activities are assessed using the IPAQ (walking, moderate-intensity activities and vigorous-intensity activities). MET is a multiple the estimated resting energy expenditure. 1 MET is energy expended while resting. For a continuous variable score from the IPAQ (MET minutes a week) walking is considered to be 3.3 METS, moderate physical activity is taken as 4 METS and vigorous physical activity is considered 8

METS. Each one of these activities gave separate scores which was used to calculate the total physical activity undertaken in a week in metabolic minutes per week (met-minutes/week); characterizing a participant as having ""high activity", "moderately activity" or "low activity" levels, if they had at least "1500 MET-minutes", "600 MET-minutes" or " less than 600 MET-minutes" per week respectively.

### 3.9.3 Anthropometric Measurements

Subjects were required to remove their shoes, socks and any overlay clothes such as coats for a weight reading on a calibrated Omron® scale to the nearest 0.1Kg. Height was measured to the nearest 0.1 cm using a stadiometer, as the maximum distance from the ground to the highest point on the head positioned in the Frankfurt plane (facing forward with nose horizontal to ground) , without shoes, feet together, and arms by the sides. BMI will be determined from these values. Waist circumference was measured at the navel (below clothing), while the subject stood erect with relaxed abdominal muscles, arms at the side, and feet together at the end of a normal expiration; using a GIMA-27342 Waist Circumference tape (Gima S.p.A, Italy) to the nearest 0.5cm. All measurements were taken twice and the average recorded.

Measurements of weight and waist circumference were done during the first and after the 12 weeks; while height was measured only during the first visit. BMI was also be calculated on all occasions.

## 3.10 Data Processing and Analysis

Data collected was tabulated in Excel spread sheets and cleaned before analyses were carried out. Shapiro-Wilk test for normality was carried out to ensure the validity of the parametric tests. Baseline data was analysed using independent samples t-tests for continuous variables including; BMI, waist circumference, diet quality (REAP-S)

scores and energy expenditure (Met-min/week), except for gender, age, household income and school/faculty which will be analysed using a chi-squared test. Baseline and follow-up means were compared using repeated measures ANOVA. In order to determine how much change occurs in diet quality, physical activity and nutritional status when there was a change the duration of app or diary use in terms of days, a multiple linear regression was used. $P < 0.05$ was considered significant when assessing differences among variables. All data was analysed using the Statistical Package for Social Sciences (SPSS (PASW), version 24, IBM Corporation. Somers, NY) as well as Microsoft Excel. Intention to treat protocol was observed, as participants were analysed based on their original groups. For missing data, last observations were carried forward.

### 3.11 Ethical Considerations

Approval for this study was sought from the Institutional Research and Ethics Committee (IREC) of Moi University, prior to any recruitment of subjects (Appendix IX). A research permit was also obtained from the National Commission for Science, Technology and Innovation (NACOSTI) (Appendix X). In addition, approvals were sought from the Nairobi County Director of Education (Appendix XI), and the Langata Subcounty Director of Education (Appendix XII). Finally, permission was sought through letters to various administrators within the colleges and universities selected as study sites (Appendix XIII).

All participants were required to give written informed consent at the initial visit. Before obtaining consent, potential candidates were given a brief overview of the research; including activities they were to participate in as well as possible time commitments towards activities of the research. Participants were recruited into the study on entirely voluntary basis and were allowed to withdraw from the study at any

time without giving reasons. They were allowed to contact the principal researcher as well as the research assistants at any time during the study to ask any questions. If for any reason they experience discomfort during participation in the study, they were free to withdraw. Individuals wishing to participate in the study were not discriminated on basis of gender, race, ethnicity, culture and disability. They neither unfairly bore the direct burdens of participating in research, nor were they unfairly excluded from the potential benefits of research participation. All the information provided by study participants was held totally anonymously, so that it will be impossible to trace this information back to the individuals. No funding was received for the conduct of this study. Therefore, I wish to declare no conflict of interests.

# CHAPTER FOUR:

# RESULTS

## 4.1 Introduction

The study managed to attract 86 prospective participants. 72 met the screening criteria and were invited via SMS for an initial visit. Of the subjects who qualified for study inclusion, 37 were randomized to the Superfit App group while 35 were placed in the Food Diary group. Twenty-nine (29) were lost to follow up during the study, after the 6th week. They either excused themselves from the study or did not respond to contact for final assessment at 12 weeks.

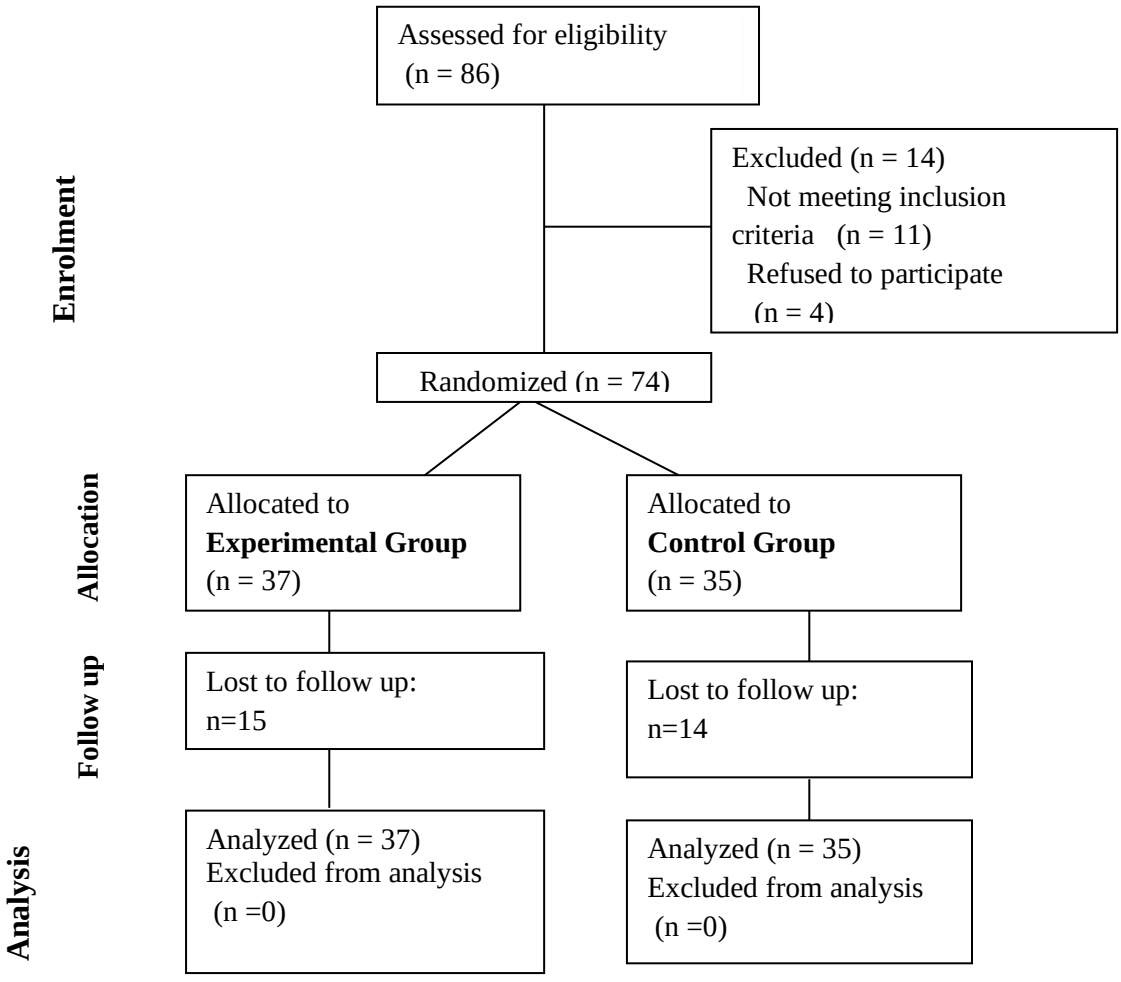


**Figure 4.1:** Consort Diagram of Study Participants

Data on baseline and endpoint characteristics including weight, waist circumference, diet quality (REAP-S) and physical activity (IPAQ) was collected and analysed as follows:

## 4.2 Distribution of Data

The Shapiro-Wilk Test showed that the data was normally distributed (Table 4.1); therefore, parametric tests were used to compare mean differences between and within groups.

**Table 4.1 : Tests of Normality**

| | Kolmogorov-Smirnova | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| WC | .133 | 34 | .136 | .954 | 34 | .163 |
| BMI | .197 | 34 | .002 | .900 | 34 | .004 |
| REAP-S | .129 | 34 | .168 | .950 | 34 | .121 |
| IPAQ | .413 | 34 | .000 | .647 | 34 | .000 |

## 4.3 Descriptive Statistics

### 4.3.1 Baseline Characteristics of Study Participants

Table 4.2 shows socioeconomic characteristics as well outcome variables of the study participants in both the experimental and control groups at baseline. This study had 60 females (83.3%) and 12 (16.7%) males. Majority of the participants (69%) were from households with a total monthly income of between KES (10,000-100,000) and studied either Law (31.9%) or Business & Commerce (26.4%). Nearly all participants were undergraduate students (83.33%).

With the exception of household income $\chi 2$ (5, N=37) = 31.11, $\rho$ =0.001) and the area of study $\chi 2$ (5, N=32) = 44.29, $\rho$ =0.001), participants in the two treatment arms were relatively similar in baseline socioeconomic characteristics.

**Table 4.2: Socioeconomic Characteristics of Study Participants**

**Table 4.2.** Socioeconomic characteristics of study participants

| | **χ2** | **df** | **ρ** | **α** |
|---|---|---|---|---|
| Sex | 0.28 | 1 | 0.600 | 0.05 |
| HH Income | 31.11 | 5 | 0.001 | 0.05 |
| Area of Study | 44.29 | 5 | 0.001 | 0.05 |
| Level of Education | 0.46 | 2 | 0.800 | 0.05 |

Table 4.3 shows the means of continuous demographic characteristics of the study participants and the main outcome variables: diet quality (REAP-S Score), physical activity (MET-Min/Week), Waist circumference (WC) and Basal Metabolic Index (BMI) at baseline. The mean age for participants was 21.49±1.91 and 21.54±2.17 for those in the experimental and those in the control group respectively.

**Table 4.3: Baseline Characteristics of Study Participants**

Baseline characteristics of study participants by treatment group

| | **Experimental (app)** | **Control (Diary)** | **tStat** | **Cohen's *d*** | ***P*** |
|---|---|---|---|---|---|
| Gender, m/f | 7/30 | 5/30 | N/A | N/A | 0.600 |
| Age, y | 21.49±1.91 | 21.54±2.17 | 0.95 | | 0.082 |
| REAP-S score | 22.84±3.287 | 22.43±3.407 | 0.52 | | 0.610 |
| MET-Min/Week | 598.43±339.07 | 523.71±244.70 | 1.07 | | 0.290 |
| WC, cm | 94.30±9.45 | 93.02±6.68 | 0.66 | | 0.513 |
| BMI, $Kg/m^2$ | 31.09±4.47 | 29.35±2.78 | 1.96 | | 0.054 |

## 4.4 Inferential Statistics

### 4.4.1 Comparing Follow-Up Outcome Variables: Independent t-Test Assuming Unequal Variance

Table 4.4 shows the main outcome variables at 6 weeks by the two treatment groups. There was a statically significant difference in the mean diet quality (REAP-S Score) and mean physical activity (MET-Min/Week) between the two groups; (P=0.001) and (P=0.001) respectively. However, the differences in mean WC and BMI were not statistically significant (P=0.304) and (P=0.073) respectively. This means that the diet quality and physical activity of participants in the experimental group improved, while WC and BMI did not improve significantly. As shown on Table 4.5; at 12 weeks, the difference between the means of all outcome variables (diet quality, physical activity, WC and BMI) was not statistically significant (P= 0.33), (P=0.18), (P=0.38) and (P=0.18) respectively. Therefore, improvements in diet quality and physical activity were not sustained for the 12 weeks study period, while WC and BMI showed no improvement.

**Table 4.4: Outcome Variables at 6 Weeks**

| Outcome variables at 6 weeks | | | | | |
|---|---|---|---|---|---|
| | **Experimental (App)** | **Control (Diary)** | **tStat** | **Cohen's *d*** | **P** |
| REAP-S | 32.95±6.79 | 28.09±5.06 | 3.43 | 0.812 | 0.001 |
| Met-Min/Week | 897.10±252.44 | 688.23±144.08 | 4.28 | 1.017 | 0.001 |
| WC | 91.67±8.64 | 89.79±6.41 | 1.04 | 0.248 | 0.304 |
| BMI | 29.46±4.43 | 27.86±2.53 | 1.86 | 0.444 | 0.073 |

**Table 4.5: Outcome Variables at 12 Weeks**

| Outcome variables at 12 weeks | | | | | |
|---|---|---|---|---|---|
| | **Experimental (App)** | **Control (Diary)** | **tStat** | **Cohen's *d*** | **P** |
| **REAP-S** | 37.18±6.67 | 35.05±7.26 | 1.00 | 0.306 | 0.33 |
| **Met-Min/Week** | 1508.75±1028.76 | 1165.30±489.27 | 1.34 | 0.427 | 0.18 |
| **WC** | 89.25±8.02 | 87.29±5.83 | 0.90 | 0.280 | 0.38 |
| **BMI** | 27.89±4.33 | 26.44±1.90 | 1.38 | 0.434 | 0.18 |

### 4.4.2 Comparing Baseline and Follow-Up Outcome Variables: ANOVA

**Diet Quality (REAP-S score)**

When the baseline and follow-up diet quality of the experimental group were compared, there was a significant difference in the mean REAP-S scores (P=0.001) within the group (Table 4.6). However, this was with a small effect size (0.091) according to Cohen's classification of effect sizes. Similarly, when the diet quality of the experimental and control groups was compared, there was a difference between the means REAP-S scores (P=0.002) over the 12 weeks, but with a small effect size (0.124).

**Table 4.6: Comparing Baseline and Follow-up Diet Quality**

| Comparison of Baseline and Follow-up Mean Diet Quality (REAP-S) score | | | | | | |
|---|---|---|---|---|---|---|
| | **Within Groups Comparison** | | | | | |
| **Predictor** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P** | **partial$\eta^2$** |
| **Time** | 5469.00 | 2 | 2734.50 | 177.25 | 0.001 | 0.717 |
| **Time * Group** | 216.746 | 2 | 108.37 | 7.025 | 0.001 | 0.091 |
| | **Between Groups Comparison** | | | | | |
| **Intercept** | 185437.29 | 1 | 185437.29 | 3254.098 | 0.001 | 0.979 |
| **Group** | 563.88 | 1 | 563.89 | 9.895 | 0.002 | 0.124 |
| **Error** | 3989.004 | 70 | 56.986 | | | |

**Physical Activity (Met-Min per Week)**

As table 4.7 shows, when a comparison of baseline and follow-up physical activity levels was done between the two groups, it was found to significantly improve over the 12 weeks (P=0.002); although, with a small effect size (0.135). The change in physical activity levels over the 12 weeks within the experimental group was not statistically significant (P=0.122).

**Table 4.7: Comparing Baseline and Follow-up Physical Activity**

Comparison of Baseline and Follow-up Physical Activity (Met-Minutes/week)

| | **Within Groups Comparison** | | | | | |
|---|---|---|---|---|---|---|
| **Predictor** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P** | **partial$\eta^2$** |
| **Time** | 14118575.372 | 2 | 7059287.69 | 42.352 | 0.001 | 0.377 |
| **Time * Group** | 713247.914 | 2 | 356623.96 | 2.140 | 0.122 | .030 |
| **Error** | 23335627.598 | 140 | 166683.05 | | | |
| | **Between Groups Comparison** | | | | | |
| **Intercept** | 154076926.262 | 1 | 154076926.262 | 684.702 | 0.000 | 0.907 |
| **Group** | 2454329.081 | 1 | 2454329.081 | 10.907 | 0.002 | 0.135 |
| **Error** | 15751933.956 | 70 | 225027.628 | | | |

**Nutrition Status**

The weight-loss experienced by participants using the app was insignificant when compared to that of those using the diary. The change in waist circumference was statistically insignificant when the two groups were compared over the 12 weeks. Similarly, when baseline and follow-up mean waist circumference were compared, the difference was not statistically significant (Table 4.8).

The change in mean BMI from baseline to 12 weeks for the experimental group was statistically insignificant. Although the difference in mean BMI was statistically

significant (P=0.001), when the experimental group was compared to control, it was with a minimal (0.141) (Table 4.9).

**Table 4.8: Comparing Baseline and Follow-up Waist Circumference**

Comparison of Baseline and Follow-up Waist Circumference

| | **Within Groups Comparison** | | | | | |
|---|---|---|---|---|---|---|
| **Predictor** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P** | **partial $\eta^2$** |
| **Time** | 641.588 | 2 | 320.794 | 143.644 | 0.001 | 0.672 |
| **Time * Group** | 3.305 | 2 | 1.653 | 0.740 | 0.479 | 0.010 |
| **Error** | 312.65 | 140 | 2.233 | | | |
| | **Between Groups Comparison** | | | | | |
| **Intercept** | 1799658.469 | 1 | 1799658.469 | 10123.930 | .000 | .993 |
| **Group** | 129.508 | 1 | 129.508 | .729 | .396 | .010 |
| **Error** | 12443.398 | 70 | 177.763 | | | |

**Table 4.9: Comparing Baseline and Follow-up BMI**

Comparison of Baseline and Follow-up BMI

| | **Within Groups Comparison** | | | | | |
|---|---|---|---|---|---|---|
| **Predictor** | **Sum of Squares** | **df** | **Mean Square** | **F** | **P** | **partial$\eta^2$** |
| **Time** | 182.085 | 1 | 182.085 | 357.774 | 0.000 | 0.836 |
| **Time * Group** | 5.846 | 1 | 5.846 | 11.487 | 0.001 | 0.141 |
| **Error** | 35.626 | 140 | .509 | | | |
| | **Between Groups Comparison** | | | | | |
| **Intercept** | 180891.107 | 1 | 180891.107 | 4696.877 | 0.000 | 0.985 |
| **Group** | 108.685 | 1 | 108.685 | 2.822 | 0.097 | 0.039 |
| **Error** | 2695.914 | 70 | 38.513 | | | |

### 4.4.3 Adherence

The relationship between use of app or diary and the main outcome variables was examined through multiple linear regressions. As shown on Table 4.10, analysis indicated there was no significant association between the duration the participants used either the app or diary and diet quality (REAP-S: β=0.46 t (70) = 0.372, ns) or physical activity (MET-min/week: β=-0.016, t (70) =-0.0131, ns).

**Table 4.10: Association Between App/Diary Use and Main Outcome Variables**

**:** Association between Duration of Intervention Use and Main Outcome Variables

| | **B** | **Std. Error** | **Beta** | **t** | **p** | **Lower Bound** | **Upper Bound** |
|---|---|---|---|---|---|---|---|
| **(Constant)** | 38.871 | 10.605 | | 3.665 | .000 | 17.715 | 60.026 |
| **REAP_S Score at 12 Weeks** | 0.112 | 0.301 | .046 | .372 | .711 | -0.489 | 0.713 |
| **Total Met-Minutes per Week at 12 Weeks** | 0.000 | 0.003 | -0.016 | -0.131 | 0.896 | -0.006 | 0.006 |

### 4.5 Quantitative and Qualitative Survey Data

More than half participants found the app "moderately satisfactory" (76%) and moderately "easy" to use (81%) (Figure 4.2 and Figure4.3). 57% of the participants found the social network to be most useful in helping them work towards achieving their goals (Figure 4.4). From the comments (Table 4.11) several subjects felt the app was too basic, while a number found difficulty with the functioning of the app. One participant commented "I think it is good, but some areas refused to work on my device". Another point arising from the comments was that no single feature or issue stood out as being consistently disliked. Other comments included the desire for more examples in the food guides, calls for a reminder function, and inability to post-date log entries.

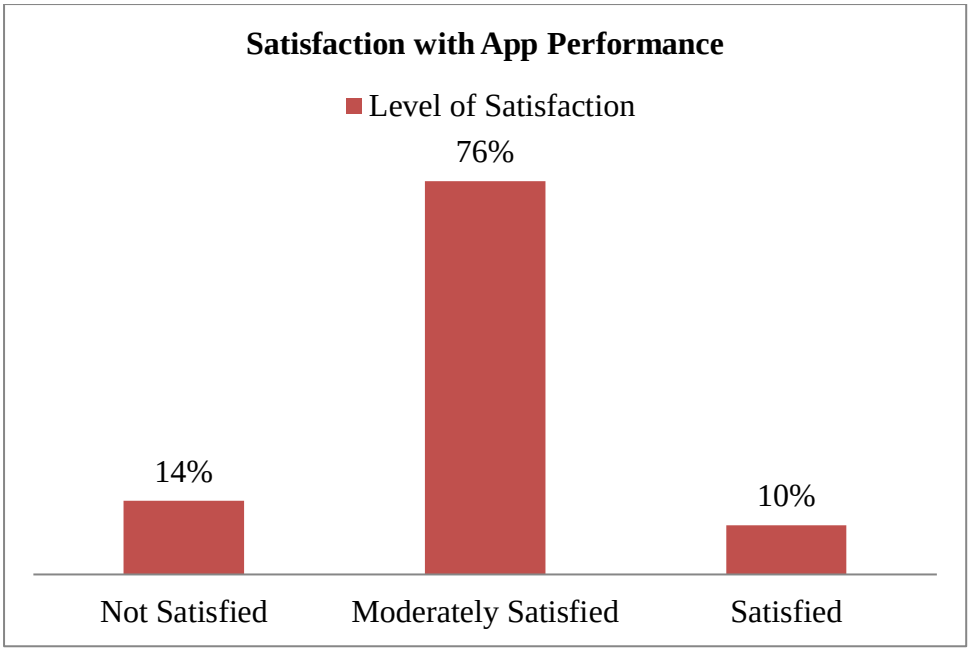


**Figure 4.2:** Level of Satisfaction with App Performance

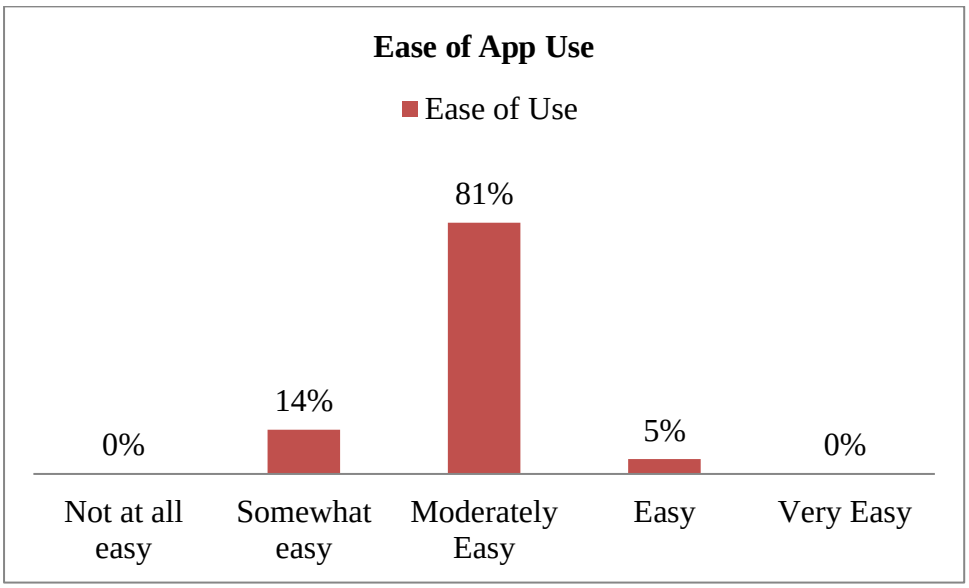


**Figure 4.3:** Ease of Using the App

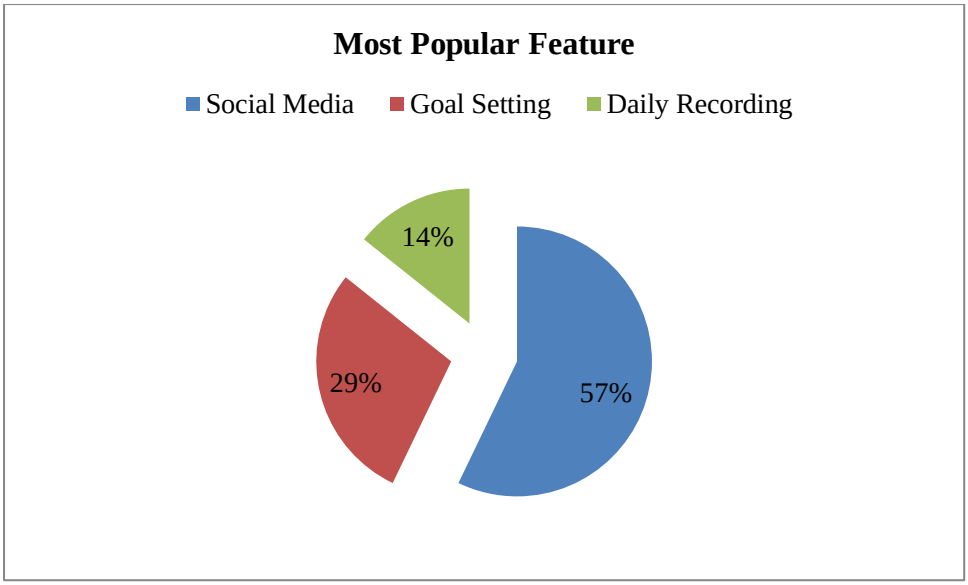


**Figure 4.4:** Most Popular App Feature

Comments by Participants

**Table 4.11: Comments Made by Participants about App**

| |
|---|
| Improve on the web access and applicability |
| some features did not work on my phone |
| navigation from one page to another should be improved |
| should make it possible to use offline |
| it should allow one to go back and post if they forget |
| should have reminders |
| make it accessible on different device types |
| more colors to show progress visually |
| reduce amount of information |
| reduce number of things to fill in |
| include timely reminders |
| make it a downloadable app |
| use simpler language on tabs |

# CHAPTER FIVE

# DISCUSSION

## 5.1 Socio-demographic Characteristics of Study Participants

In this study, a total of 12 males and 60 females participated. This was probably linked to differences in image perceptions between the two gender groups. A study by (Holdsworth et al., 2004) reported that among African cultures, fatness was associated with wealth, health and prosperity. However, with improvement in technology, people especially women are becoming more aware of the health implication of obesity. In addition, the mean age of the participants was about 21 years. In this late adolescent age, females particularly are more aware about their body image and are keen to control their weight when they are perceived as fat (Gitau et al., 2014).

Most of participants (69%) came from households where the households were earning a monthly income of between 10,000 and 100,000 Kenyan Shillings. Studies have found that obesity and overweight are no longer experienced by the rich only, but also now among middle income earners and the poor economically (Ziraba, Fotso, & Ochako, 2009). Data from the KDHS, (2014) had similar findings. According to Kigaru et al., (2015), the reason most likely pointed to support this among the youth is that most eateries and restaurants found within and near the schools they are sell mostly fast foods. These are also the cheaper and are most likely the choice of their food daily.

Majority of the participants were either in the Faculty of Law (31.9% ) or the School of Business and Commerce (26.4%). This was likely because of snowballing; thus, majority of subjects who accepted to participate in the study were pursuing these courses. Similarly, most of the participants (83.33%) were undergraduate students.

Since this is the highest category of students enrolled at universities, the study was likely to recruit them due to the snowballing effect.

### 5.2 Diet Quality

According to this study's findings, the diet quality of the participants was quite poor (Mean REAP-S score 22.64 ±3.34) at baseline. This means they were not eating enough whole grains, fruits and vegetables and their salt, fat and sugar intake was quite high. At 6 weeks, both groups (experimental and control) improved their diet quality (Mean REAP-S score 32.95 ± 6.79 and 28.09 ± 5.06 respectively). However, the participants in the app group had a better diet quality since the difference in means between the groups was statistically significant (P=0.001), with an effect size of (0.812). Therefore, the app likely conferred benefits to those who were using it by helping them monitor their dietary intake.

Nonetheless, this improvement was not sustained for the entire study period. At 12 weeks, although the diet quality showed improvement for the experimental and control groups (Mean REAP-S score 37.18 ± 6.67 and 35.05 ± 7.26) respectively, the difference between the two groups was not statistically significant (P=0.33) and the effect size was quite low (.0306). This means that the benefits conferred by the app to the experimental group were short lived.

It is also important to note that there was a positive association between the diet quality of participants and the time spent using either the app or the diary intervention for within and between groups (P=0.001 and P=0.002 respectively); however, with low effect sizes (0.091 and 0.124 respectively).

The findings at 6 weeks indicate all participants benefited from the healthful DASH eating plan which promotes an increase in whole grains, fruit and vegetable intake and a decrease in fat, sugar, and salt intake. According Reedy et al., (2014), this kind of diet provides not only an overall benefit to one's health, but also protective advantage against cardiovascular disease.

Conversely, the DASH diet plan contains many food groups, with strict limit intakes. According to Dansinger, Gleason, Griffith, Selker, & Schaefer, (2005) such kinds of rigid diets can lead to non-compliance. This may have contributed to the insignificant findings at 12 weeks. Although both treatment groups observed an evidence-based wholesome diet, it is worth noting the Superfit group maintained a somewhat higher diet quality compared to that of Food Diary group. In other words, participants in both groups consumed and adhered to a healthy eating plan, but participants in the experimental group achieved a better diet quality by using the app. Therefore, subjects appear to have gained more from limits enforced by using the app than from suggested goals as these were not enforced by a Food diary.

### 5.3 Physical Activity

At baseline, this study's participants' physical activity levels were low (Mean 562.11 ± 297.00 MET-Min/Week). This is in line with studies carried out in the Kenyan context, showing that the levels of physical activity were quite low. Modernization and improved living standards have led to behavioural transitions into more sedentary lifestyles, which in turn have resulted into increased proportions of overweight and obese children in Africa (Muthuri et al., 2014). For participants in this study, most spend long hours in school taking classes while seated every day of the week. In addition, availability of technology that aids in transportation has led to decline in time spent

walking. Likewise, technology that assists people to carry-out tasks at home reduces time spent on chores and the amount of energy expended during work.

Participants' activity levels improved after 6 week as both participants in the Superfit App and Food Diary groups had moderate physical activity levels (Mean 897.10 ± 252.44 MET-Min/Week and 688.23 ± 144.08 MET-Min/Week respectively). The differences between the two groups in mean MET-Min/Week was statistically significant (P=0.000). There was no significant difference in physical activity (in MET-min/week) within groups when baseline was compared to follow-up, but there was a significant difference between experimental and control groups over the 12 weeks .(P=0.002, with an effect size of 0.135). However, it is worth noting that most participants increased their physical activity from low to moderate PA levels (≥600 MET-min/week) at 6 and 12 weeks. In a study by Janssen et al., (2017) when individuals can measure their progress, they were more motivated to train for a marathon. This underscores the importance of m-Health software such as Superfit app which help users track not only their dietary intake, but also their physical activity levels.

Findings related to physical activity are important since physical inactivity is heavily associated with the development of many chronic diseases. Therefore, even a slight increase in activity confers benefits towards reduction in NCD risk. According to Durstine, Gordon, Wang, & Luo, (2013), physical activity is considered key in interventions for primary and secondary prevention of chronic diseases. Further, Durstine et al., (2013) emphasized the primary prevention of disease as necessary to reduce NCD risk in youth and adults.

### 5.4 Nutrition Status

The subjects in the app group did not lose weight significantly. The differences in BMI at 6 and 12 weeks were insignificant when compared between the two groups, and although there was a positive change (P=0.001) over the 12 weeks when compared to baseline the effect size was small (0.141). This finding is consistent with a study by (Scholtz, 2016); who found that although the experimental app did not significantly lose weight, the experimental group improved their BMIs significantly more than the control group (with an adequate effect size of 0.145). Participants in this study would be classified as being overly obese with a Mean BMI of 30.24 ± 3.75 and Waist Circumference (WC) of 93.68 ± 8.19 at baseline. This was above the normal WHO cut-offs of (18.0-24.9 $Kg/M^2$) and (< 80 cm, women; <94 cm, men) for BMI and WC respectively. Although participants lost a modest amount weight at 6 weeks (Mean WC 90.76 ± 7.51 cm and Mean BMI 28.68 ± 3.63 $Kg/M^2$) and at 12 weeks (Mean WC 88.30 ± 7.04 cm and Mean BMI 27.19 ± 3.38 $Kg/M^2$). However, this was statistically insignificant for both WC and BMI (P=0.30 and P=0.07 respectively) at 6 weeks and (P=0.38 and P=0.18 respectively) at 12 weeks. Also, there was no significant difference in the change in WC within or between groups over time. Another study found that the DASH eating plan was effective in weight loss (Reedy et al., 2014). These findings were important also because of the associated benefit of an overall healthy eating pattern with whole grains, vegetables, fruit, and plant-based proteins.

These findings are of importance because: since height remains constant when weight changes, subjects are actually changing their body compositions when viewed in the lens of BMI (Blackwell et al., 2014). In addition, this study showed that there is a positive association between low BMI and successful long-term weight maintenance. In addition, it is worth mentioning that a lower BMI meant participants reaped health

benefits from the DASH diet plan since a lower BMI is correlated with decreased risks of type 2 diabetes, hypertension, and cardiovascular disease. Tucker & Thomas, (2009) found diets high in fruits, vegetables, and fiber were associated with lower subject BMIs. In addition, persons who ate low-fat dairy and consumed little or no meat also had lower BMIs. It should be noted that similar patterns were encouraged by the Superfit app which permitted higher vegetable intake (5 to 7 portions) but set limits on carbohydrates, dairy, fat, sugar and salt.

Although the decrease in waist circumference was not significant between groups or within groups over time, it has been long determined to have a significant role in adult metabolic syndrome (WHO Expert Consultation, 2008). Waist circumference is an indicator of body fat distribution, that is useful in identification of those at increased risk of obesity-related cardiometabolic disease, above and beyond the measurement of BMI (Klein et al., 2007). According to (Manning et al., 2016), a decline in waist circumference confers benefits in treatment of NCDS related to obesity.

### 5.5 Adherence

This study's findings related to adherence were not significant since no association was found between the length of days the participants used the app and the change in the main outcome variables (diet quality and physical activity). However, it is important to note that the app had several participatory burdens (including stable internet connection). This study's relatively brief, twelve-week time frame may explain this outcome. Significant weight-loss has not been realized before 20 weeks (Dansinger et al., 2005) . Another study by (Wharton et al., 2014), where a weight loss app was studied failed to show significant weight loss differences over the short timeframe used in the study. This is because, changing one's eating habits and diet patterns takes time

(Strecher et al., 1986) . According to Wing et. al (2005)'s review of successful strategies regarding weight loss maintenance, diet quality was found to promote and maintain weight loss. However, this was only if adherence was maintained ≥ 1 year.

## 5.6 Limitations and Delimitations

The randomized controlled approach of this study was advantageous since randomization resulted in the two groups of subjects in the study being comparable with respect not only known prognostic factors, but also with regard to unknown factors, e.g., genetic factors, that might affect the outcome. In addition, the experimental nature of this study makes the results conclusive.

The most apparent limitation of this study was the experimental nature of the Smartphone application. Since it has been recently developed for the sake of the study, testing and debugging was not sufficient to eliminate all possible errors on the app. Since participants are allowed to contact the principal investigator, any problems that arise with the use of app were attended to as they are pointed by the users. Moreover, since the application requires internet use, it did not provide flexibility during use. With sufficient funding, this problem can be solved as by converting the app to non-internet based. Another limitation was lack of compliance associated with self-report methods used (app and diary), which may have led to reporting bias or recall problems. Additionally, since this study utilized voluntary response samples there was high likelihood to oversample people who have strong interest in weight loss and under-sample people who did not care much about the topic of the study. As a result, inferences from this study sample may not be as trustworthy as conclusions that would be based on a random sample of the entire population. Drawing such conclusions is a form of extrapolation as the sampling method systematically excluded non-interested

parts of the population; hence the inferences only apply to the subpopulation which has actually been sampled. Because of the difficulty or impossibility of obtaining good data, extrapolation is the best we can do.

The small group sizes posed a limitation. There could have been an increased risk of a type 2 statistical error in which group differences existed but were overlooked. In cases such as this, effect size can be calculated to quantify the difference. An effect size from 0.06 to 0.14 is considered moderate. For the change in body weight, the repeated measures ANOVA subjects groups (P=0.140) was not significant and the effect size (0.079) was moderate. This analysis provides additional reassurance for the continued examination of Superfit App to promote weight loss.

Another potential problem with the samples was the high number of subject dropouts. Unfortunately, the exit surveys do little to explain the disparity in drop rates. In fact, only one subject cited the app design as a withdrawal justification.

Another limitation of the study was its low external validity. The study attracted mostly young adults. Their socioeconomic statuses combined with their health-related interests do not represent the greater Nairobi population. On the other hand, there was good ecological validity (a component of external validity). The study design encouraged a realistic, real-world atmosphere. Subjects received minimal app training and diet instruction. Few constraints were placed on the subjects. During the intervention, subjects were left to their own volitions. Other than a single mid-point email, investigators made no attempt to remind subjects about app usage or diet adherence.

In another study by Sholtz, 2016, the MyPlate group's BMIs at baseline and post-test were almost indistinguishable. It calls into question whether this diet provides

sufficient guidelines for weight loss. A successful eating framework should stipulate clear intake limits. MyPlate gives daily recommended intakes based on age and gender. However, it does not specifically instruct a dieter when to stop eating. MyPlate's focus on "recommended daily amounts" may not convey a sense of finite quantities. Even worse, the use of goals could be misconstrued by laypersons as "more is better". After all, exceeding a goal is often a desirable outcome. A more encompassing level of diet detail may also be beneficial.

By contrast, the Superfit outlines specific serving limits and utilizes eight primary food groups including fats, sweets, and alcohol. Smartphone diet apps vary greatly in their complexity, feature set, and availability across platforms. A key strength of this study was its custom-designed software. In this regard, the Superfit app may have provided improved usability as compared to more complex commercial apps.

### 5.7 Conclusions

This study rejected its first and second null hypotheses, while the third was validated. The diet quality of the sample of youth who used the web application was higher than the diet quality of those who did not use it. Similarly, the physical activity levels of those participants who used the app increased significantly more than the ones in the control group. On the other hand, there was no difference in weight-loss between participants in the app group and those in the control group. The nutritional status BMI and waist circumference of the sample of youth who used the Smartphone web application were not different than those who did not use it. Therefore, this study showed to a moderate extent that m-health technologies such as the Superfit app can be used in the Kenyan context to improve the diet quality and physical activity of youthful populations.

## 5.8 Recommendations

Although this study proved to a modest extent the effectiveness of m-health software in improving diet quality and physical activity. The results are encouraging for professionals in the field of Public health nutrition who are seeking solutions for tackling the problem of overweight, obesity. Since the most promising findings were the improvement in diet quality, physical activity and weight-loss shown by a reduction in BMI this study recommends that nutrition professionals wanting simple, affordable ways of delivering weight loss interventions utilize m-Health platforms because these allow many clients to be targeted at one time.

Since the resulting data on diet quality and physical activity contain interesting trends, researchers interested in m-health technology can investigate interlinkages between factors such as socioeconomic characteristics on elements such as acceptability and adherence, to such apps. Data on BMI also showed optimistic trends and may have been diminished by the small study sample. A logical next step is to open Superfit app to the public, once its functionality has been improved. This would potentially allow for studying a large cohort.

The findings of this study on diet quality and physical activity may be of interest to overweight and obese individuals among the Kenyan population. Such individuals may have the possibility of simply tracking their dietary intake and physical activity through m-Health technology such as the Superfit app. This might be more effective as in helping them achieve their weight-loss goals compared to having none or doing manual recording in a diary. In today's world of shortened attention spans, a faster diet app such as the Superfit would likely be a popular tool to aid in weight loss through tracking and adequate reminders.

The Kenyan government through the Ministry of health has eating and physical activity guidelines which encourage consumption of balanced meals and exercise. However, guidelines without practical steps may not be sufficient healthy eating, improving physical activity and for weight loss. The findings in the study support the concept that a diet with set intake limits and broader food group coverage may outperform one without such guidelines. Government policies such as these provided by the Kenyan government may benefit from additional dietary structure provided by m-health technologies such as the Superfit App.

### 5.9 Dissemination of Results

Findings of this research will be published as articles in professional journals. They will also be presented in local and international forums to enable supportive and critical discussion of findings and their implications on practice. In addition, collaborations with policy-making authorities will be pursued in order to explore how the research findings can fit into future policy, in ways that could improve practice at all levels including; prevention and management of NCDs, for the sake of effective outputs.

From these meetings actionable messages and recommendations will be generated for wider dissemination, through a multi-faceted approach including: media campaigns and social media (e.g. Facebook).

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# APPENDICES

## Appendix I: Action Plan

| | |
|---|---|
| 1. | Seek permission from selected institutions |
| 2. | Post advertisements for on notice boards and students' social media pages and groups |
| 3. | Email Google Forms questionnaire to interested participants |
| 4. | Evaluate participants based on selection criteria |
| 5. | Stratify and randomize to Superfit or Control groups |
| 6. | Visit 1 (Week 1): Initial Screening<br>· consent form<br>· diet survey<br>· height measurement<br>· weight measurement<br>· waist circumference measurement<br>· diet and app training (for Superfit group) |
| 7. | Visit 2 (Week 6): Mid-point<br>Repeat:<br>· diet survey<br>· height measurement<br>· weight measurement<br>· waist circumference measurement |
| 8. | Visit 3 (Week 12): End-point<br>Repeat:<br>· diet survey |

| | |
|---|---|
| | · height measurement<br>· weight measurement<br>· waist circumference measurement |
| 9. | Week 13<br>Email post study questionnaire |

**Appendix II: Timelines**

| **Dates** | **Activity** |
|---|---|
| September 2016 | Complete design of Online Interphase of App |
| | Complete Design of Smartphone Application |
| | Debugging the Application |
| Dec 2017 | Completion of Proposal |
| Jan 2018 | Submission of proposal to IREC |
| Mar 2018 | IREC approval |
| April 2018 | NACOSTI permit |
| May 2018 | Sampling |
| June 2018 | Pilot study |
| July 2018 | Baseline Data collection |
| Mid August 2018 | 6 Week end point data collection |
| End Sept 2018 | 12 Week end point data collection |
| Oct 2018 | Data Analysis |
| Nov 2018 | Final Thesis |

**Appendix III: Budget**

| **ITEM** | **COST (KES)** |
|---|---|
| Equipment | 30,000 |
| Printing | 12,000 |
| Travel | 10,000 |
| Communication | 5,000 |
| Application Hosting | 5,000 |
| Technical Assistance | 15,000 |
| Research Assistants | 18,000 |
| **Sub-total** | 95,000 |
| Overhead | 9,500 |
| **Total** | 104,500 |

**Appendix IV: Google Forms Questionnaire**

1. Email address:
2. Phone Number:
3. Sex:

   □Female

   □Male

4. Age:

   □ Under 19

   □ 19-22

   □ 23-26

   □ 27-30

   □ 31-35

5. Name of University/College:
6. Level of Education:

   □ Undergraduate student

   □Graduate student

   □ Professional student

   □Diploma student

   □ Higher diploma student

7. Stage/year:

   □Freshman

   □Continuing student

   □ Final year student

8. College/ school:

   □Agriculture & Life Sciences

   □Applied Sciences

   □Architecture and Landscape Architecture

   □Education

 Business and commerce

Engineering

Fine Arts

Humanities

Medicine/ Nursing/Pharmacy/Public Health

Social & Behavioural Sciences

9. Which of the following are applicable to your living situation?

 I live alone

 I live with other students.

 I live with roommates who are not students.

 I live with parents(s), relative(s), or guardian(s).

 I live with a husband/wife/domestic partner/significant other

 I live with my child/children

10. Which of the following describes where you currently live?

Campus hostels

 Off-campus hostels

 Off-campus housing (rentals)

 Living at home with family/relatives

11. Which of the following best describes your total household (family) income?

 Below KES 10,000

KES 10,000 to 50,000

KES 51,000 to 150, 000

Above 150,000

**Appendix IV: Consent Form**

*Effectiveness of a Smartphone web application in Improving Diet Quality, Physical Activity and Nutritional Status among Youth in Nairobi County, Kenya*

My name is Thalma Orado, and I am a Master of Public Health Student at Moi University. I am inviting you to participate in a research study. Involvement in the study is voluntary, so you may choose to participate or not. This sheet will explain the study to you and please feel free to ask questions about the research if you have any. I will be happy to explain anything in detail if you wish.

I am interested in assessing whether a Smartphone web application can be used to improve diet, physical activity and nutritional status among young adults. You will be asked to use the Smartphone web application as a guide to your dietary and physical activity behaviour for 4 months. At the beginning of the study period, after 2 months and at the end of 4 months, you will be asked to respond to survey questions regarding your dietary and physical activity behaviour. At the end, another short survey on your experiences using the application will also be requested of you. The surveys will take approximately 15 to 30 minutes of your time. All information will be kept confidential and when I write a report for this research project, I will use coded language to identify you during the study and not your actual name.

The importance of you participating in this research is that you will be helping me evaluate whether the application has the potential to help not just young adults but other Kenyans in general, change their dietary and physical activity behaviour and thus improve their nutritional status and consequently health. Based on this information, I will be able to recommend the application for use by the general Kenyan public. The potential benefits of you by taking part in this research is that you will improve your diet by choosing healthier food options, improve your physical activity levels by choosing a more active lifestyle, lose weight and consequently improve your health.

The dietary and physical activity guidelines used in this study are based on sound research and unlike some other diets that might eliminate essential foods or have adverse side effects; these guidelines do not have any known negative side effects. Though any new diet might be challenging at the start, depending on your previous eating habits, the guidelines in this study have many benefits that make it easier to follow. They have been observed to be well tolerated by participants in other studies, with no increase in symptoms. However, initially, you may experience slight stomach discomfort as a gastrointestinal side effect of suddenly increasing non-starch polysaccharides (from fruits and vegetables). The risk of participating in the surveys is minimal although you may experience some form of mental fatigue. Therefore if you do not want to take part, you have the right to refuse without penalty. If you decide to take part and later no longer wish to continue, you also have the right to withdraw from the study at any time without penalty. Should you experience any side effects as result of participating in the study and therefore need specialized care, I am more than willing to refer you to a physician for assistance.

If you have any questions, concerns, complaints about the research, email Dr. Susan Keino of Moi University through susankeinoil@gmail.com. If you have any questions about your rights as a research participant, you have questions, concerns, or complaints that you wish to address to someone other than the investigator, contact the Institutional Research and Ethics Committee of Moi University on 0787723677 or email contact@irec.or.ke.

All of my questions have been answered, I am over the age of 18 years and I wish to participate in this research study. I have received a copy of this consent form.

Please tick (√) appropriately:

___ I agree to participate in this study by using the Smartphone web application and responding to survey questions.

___ I do not agree to participate in this study by using the Smartphone web application and responding to survey questions.

_____ _____

Signature of participant Date

_____

Printed name of participant

_____ _____

Signature of researcher Date

_____

Printed name of researcher

**Appendix V: Health History Questionnaire**

**SOCIAL HISTORY**

Gender: □Male □Female Marital Status: □Single □Married □Divorced

Do you have children? □Yes □No How many? _____

Are you breastfeeding, pregnant, or looking to become pregnant in the next 4 months?

□Yes □No

Tobacco Products: Do you use, or have you ever used any tobacco products? □Yes □No □Quit

If yes: □cigarettes □chew □pipe □ smokeless How much used per day? _____

Year you started? _____ If you quit, when? _____

Alcohol: Do you drink any alcoholic beverages? □Yes □No

How many alcoholic beverages do you consume: □Daily ____□Weekly ___□ Monthly_____?

History of Drug Use: □Yes □No If you quit, when? _____

If yes, type(s) of drugs: _____

**MEDICAL INFORMATION**

Circle Y for Yes and N for No for any of the following diagnosed (known) conditions in the past or present:

Y N Diabetes: □Type 1 □Type 2 □Gestational

Y N Arthritis, joint pain:

Y N High blood pressure

Y N High cholesterol

Y N Heart disease / Heart attack. Date of heart attack: _____
□Bypass □Stent □Angioplasty

Y N Chest pain, angina

Y N Chronic low back pain

Y N Mobility assistance If Yes, do you use a:

□Cane □Walker □Wheelchair/Scooter

| | | |
|---|---|---|
| Y | N | Heart failure |
| Y | N | Stroke |
| Y | N | Sleep Apnea |
| Y | N | Asthma |
| Y | N | Emphysema / COPD |
| Y | N | Thyroid disease: □ Hypothyroidism □Hyperthyroidism |
| Y | N | Have you ever had Blood Clot, Deep Vein Thrombosis (DVT), or Pulmonary Embolism (PE)? |
| Y | N | Gastroesophageal Reflux Disease (GERD), heartburn, indigestion |
| Y | N | Ulcers: Stomach / Esophagus / Small intestine |
| Y | N | Crohn's Disease, Ulcerative Colitis, Colitis |
| Y | N | Irritable Bowel Syndrome |
| Y | N | Gallbladder disease / Gallstones Gallbladder removed? Yes No |
| Y | N | Fatty liver disease |
| Y | N | Cancer, type: _____ Date Diagnosed: _____ Surgery date and type: _____ Radiation (Date completed): _____ Chemo (Date completed): _____ |
| Y | N | Lupus |
| Y | N | Kidney Disease |
| Y | N | Have you ever had Blood transfusion(s)? Date(s):_____ |
| Y | N | Hepatitis: □B □C □Autoimmune |
| Y | N | Polycystic ovarian syndrome |
| Y | N | If female, date of last menstrual period:_____ |
| | | Heavy menstrual bleeding □Yes □No |
| Y | N | Previous bariatric surgery |
| Y | N | Previous Transplant Type: _____ |
| Y | N | Psychological Diagnosis (Past or Present): □Anxiety □Depression □Panic Attacks □Bipolar Disorder |
| | | Other: _____ |

**Surgeries**: Please include the dates

Date Surgery

**Medications**: What medications do you take on a regular basis?

Include any over-the-counter herbal, vitamins, minerals, and prescription drugs.

Medication Dosage (mg/IU/gm, etc.) How Often (times/day) Why do you take it?

**ALLERGIES:** Are you allergic to any drug, food or substance (Example: Latex)? If yes, what happens when you take or are exposed to it?

Drug/Food/Substance Reaction

**NUTRITION INFORMATION**

**Height / Weight**

Current height (in centimeters):_____ At what age did your weight became a problem? _____

Current weight (in kilograms): _____ Highest weight (in kilograms): _____

Your desired goal weight (in pounds): _____

**Weight loss attempts**

Please indicate all weight loss attempts you have tried. Check all the boxes that apply.

- □ Calorie counting
- □ Laxatives
- □ Low / no carb diet
- □ Exercise
- □ Medications
- □ Fasting
- □ Portion control
- □ Vomiting after eating
- □ Liquid diet

Others (please list):_____

_____ Printed

Name of person who completed this form _____/_____/_____ Date (dd/mm/yyyy)

**Appendix VI: Diet Quality Assessment Questionnaire (REAP-S)**

Source: (CJSegal-Isaacson et al., 2003)

| **In an average week, how often do you:** | **Usually/ Often** | **Sometimes** | **Rarely/ Never** | **Does not apply to me** |
|---|---|---|---|---|
| 1. Skip breakfast? | o | o | o | |
| 2. Eat 4 or more meals from sit-down or take out restaurants? | o | o | o | |
| 3. Eat less than 2 servings of whole grain products or high fibre starches a day? Serving = 1 slice of 100% whole grain bread; 1 cup whole grain cereal like Shredded Wheat, Wheaties, Grape Nuts, high fibre cereals, oatmeal, 3-4 whole grain crackers, ½ cup brown rice or whole wheat pasta, boiled or baked potatoes, yucca (cassava), yams or plantain. | o | o | o | |
| 4. Eat less than 2 servings of fruit a day? Serving = ½ cup or 1 med. fruit or ¾ cup 100% fruit juice. | o | o | o | |
| 5. Eat less than 2 servings of vegetables a day? Serving = ½ cup vegetables, or 1 cup leafy raw vegetables. | o | o | o | |
| 6. Eat or drink less than 2 servings of milk, yogurt, or cheese a day? Serving = 1 cup milk or yogurt; 1½ - 2 ounces cheese. | o | o | o | |
| 7. Eat <u>more than</u> <u>8 ounces</u> (see sizes below) of meat, chicken, turkey or fish <u>per day</u>? ***Note**: 3 ounces of meat or chicken is the size of a deck of cards or ONE of the following: 1 regular hamburger, 1 chicken breast or leg (thigh and drumstick), or 1 pork chop.* | o | o | o | **Rarely eat meat, chicken, turkey or fish** o |
| 8. Use regular processed meats (like bologna, salami, corned beef, hotdogs, sausage or bacon) instead of low fat processed meats (like roast beef, turkey, lean ham; low-fat cold cuts/hotdogs)? | o | o | o | **Rarely eat processed meats** o |

| | | | | | |
|---|---|---|---|---|---|
| 9. Eat fried foods such as fried chicken, fried fish, French fries, fried plantains (banana), tostones (double fried plantain) or fried yucca (cassava)? | o | o | o | | |
| 10. Eat regular potato chips (crisps), nacho chips, corn chips, crackers, regular popcorn, nuts instead of pretzels, low-fat chips or low-fat crackers, air-popped popcorn? | o | o | o | **Rarely eat these snack foods** o | |
| 11. Add butter, margarine or oil to bread, potatoes, rice or vegetables at the table? | o | o | o | | |
| 12. Eat sweets like cake, cookies, pastries, donuts, muffins, chocolate and candies more than 2 times per day. | o | o | o | | |
| 13. Drink 16 ounces or more of non-diet soda, fruit drink/punch or Kool-Aid (other soft drinks) a day? Note: 1 can of soda = 12 ounces (350 ml) | o | o | o | | |
| | **YES** | | **NO** | | |
| 14. You or a member of your family usually shops and cooks rather than eating sit-down or take-out restaurant food? | o | | o | | |
| 15. Usually feel well enough to shop or cook. | o | | o | | |
| 16. How willing are you to make changes in your eating habits in order to be healthier? | 1 **Very willing** | 2 | 3 | 4 | 4 **Not at all willing** |

**Appendix VII: Physical Activity Assessment Questionnaire (IPAQ)**

Source: (Karolinska Institute, 2002)

I am interested in finding out about the kinds of physical activities that you do as part of your everyday life. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard (garden) work, to get from place to place, and in your spare time for recreation, exercise or sport.
Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

***PART 1: JOB-RELATED PHYSICAL ACTIVITY***
The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. **Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family.** These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?
Yes ☐
No →***Skip to PART 2: TRANSPORTATION***
The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. **(This does not include traveling to and from work.)**

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**?
Think about only those physical activities that you did for at least 10 minutes at a time.
_____ **Days per week**
No vigorous job-related physical activity →***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?
_____ **Hours per day**
_____ **Minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.
_____ **Days per week**
No moderate job-related physical activity →***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?
_____ **Hours per day**
_____ **Minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.
_____ **Days per week**
No job-related walking →***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?
_____ **Hours per day**
_____ **Minutes per day**

***PART 2: TRANSPORTATION PHYSICAL ACTIVITY***

These questions are about how you traveled from place to place, including to places like work, stores (supermarkets, shops etc.), movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or motorcycle?
_____ **Days per week**
No traveling in a motor vehicle →***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, motorcycle, or other kind of motor vehicle?
_____ **Hours per day**
_____ **Minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.
10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?
_____ **Days per week**
No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?
_____ **Hours per day**
_____ **Minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?
_____ **Days per week**
No walking from place to place →***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?
_____ **Hours per day**
_____ **Minutes per day**

***PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time.
During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?
**_____ Days per week**
No vigorous activity in garden or yard ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?
**_____ Hours per day**
**_____ Minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?
**_____ Days per week**
No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?
**_____ Hours per day**
**_____ Minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?
**_____ Days per week**
No moderate activity inside home → ***Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?
**_____ Hours per day**
**_____ Minutes per day**

***PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY***

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?
**_____ Days per week**
No walking in leisure time → ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?
_____ **Hours per day**
_____ **Minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time.
During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?
_____ **Days per week**
No vigorous activity in leisure time → ***Skip to question 24***

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?
_____ **Hours per day**
_____ **Minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?
_____ **Days per week**
No moderate activity in leisure time → ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?
_____ **Hours per day**
_____ **Minutes per day**

***PART 5: TIME SPENT SITTING***

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?
_____ **Hours per day**
_____ **Minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?
_____ **Hours per day**
_____ **Minutes per day**

**This is the end of the questionnaire, thank you for participating ☺☺**

**Appendix VIII: DASH Guidelines for Counseling Pamphlet**

# Following the DASH Eating Plan

Use this chart to help you plan your menus—or take it with you when you go to the store.

| Food Group | Servings Per Day | | | Serving Sizes | Examples and Notes | Significance of Each Food Group to the DASH Eating Plan |
|---|---|---|---|---|---|---|
| | 1,600 Calories | 2,000 Calories | 2,600 Calories | | | |
| Grains* | 6 | 6-8 | 10-11 | 1 slice bread<br>1 oz dry cereal†<br>½ cup cooked rice, pasta, or cereal | Whole wheat bread and rolls, whole wheat pasta, English muffin, pita bread, bagel, cereals, grits, oatmeal, brown rice, unsalted pretzels and popcorn | Major sources of energy and fiber |
| Vegetables | 3-4 | 4-5 | 5-6 | 1 cup raw leafy vegetable<br>½ cup cut-up raw or cooked vegetable<br>½ cup vegetable juice | Broccoli, carrots, collards, green beans, green peas, kale, lima beans, potatoes, spinach, squash, sweet potatoes, tomatoes | Rich sources of potassium, magnesium, and fiber |
| Fruits | 4 | 4-5 | 5-6 | 1 medium fruit<br>¼ cup dried fruit<br>½ cup fresh, frozen, or canned fruit<br>½ cup fruit juice | Apples, apricots, bananas, dates, grapes, oranges, grapefruit, grapefruit juice, mangoes, melons, peaches, pineapples, raisins, strawberries, tangerines | Important sources of potassium, magnesium, and fiber |
| Fat-free or low-fat milk and milk products | 2-3 | 2-3 | 3 | 1 cup milk or yogurt<br>1½ oz cheese | Fat-free (skim) or low-fat (1%) milk or buttermilk; fat free, low fat, or reduced-fat cheese; fat-free or low-fat regular or frozen yogurt | Major sources of calcium and protein |
| Lean meats, poultry, and fish | 3-6 | 6 or less | 6 | 1 oz cooked meats, poultry, or fish<br>1 egg‡ | Select only lean meats; trim away visible fat; broil, roast, or poach; remove skin from poultry | Rich sources of protein and magnesium |
| Nuts, seeds, and legumes | 3 per week | 4-5 per week | 1 | ½ cup or 1½ oz nuts<br>2 Tbsp peanut butter<br>2 Tbsp or ½ oz seeds<br>½ cup cooked legumes (dry beans and peas) | Almonds, hazelnuts, mixed nuts, peanuts, walnuts, sunflower seeds, peanut butter, kidney beans, lentils, split peas | Rich sources of energy, magnesium, protein, and fiber |
| Fats and oils§ | 2 | 2-3 | 3 | 1 tsp soft margarine<br>1 tsp vegetable oil<br>1 Tbsp mayonnaise<br>2 Tbsp salad dressing | Soft margarine, vegetable oil (such as canola, corn, olive, or safflower), low-fat mayonnaise, light salad dressing | The DASH study had 27 percent of calories as fat, including fat in or added to foods |
| Sweets and added sugars | 0 | 5 or less per week | ≤2 | 1 Tbsp sugar<br>1 Tbsp jelly or jam<br>½ cup sorbet, gelatin<br>1 cup lemonade | Fruit-flavored gelatin, fruit punch, hard candy, jelly, maple syrup, sorbet and ices, sugar | Sweets should be low in fat |

* Whole grains are recommended for most grain servings as a good source of fiber and nutrients.
† Serving sizes vary between ½ cup and 1¼ cups, depending on cereal type. Check the product's Nutrition Facts label.
‡ Because eggs are high in cholesterol, limit egg yolk intake to no more than four per week; two egg whites have the same protein content as 1 oz of meat.
§ Fat content changes serving amount for fats and oils. For example, 1 Tbsp of regular salad dressing equals one serving; 1 Tbsp of a low-fat dressing equals one-half serving; 1 Tbsp of a fat-free dressing equals zero servings.

Abbreviations: oz = ounce; Tbsp = tablespoon; tsp = teaspoon

## Appendix IX: IREC Approval

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET

Reference: IREC/2017/224
**Approval Number: 0002057**

28th March, 2018

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
28 MAR 2018
P. O. Box 4606 - 30100 ELDORET

Thalma Orado,
Moi University,
School of Public Health,
P.O Box 4606-30100
ELDORET-KENYA.

Dear Ms. Orado,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

***"Effectiveness of a Smartphone Web Application in Improving Diet Quality, Physical Activity and Nutritional Status among Youth in Nairobi County, Kenya".***

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 2057*** on 28th March, 2018. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 27th March 2019. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

## Appendix X: NACOSTI Permit

THIS IS TO CERTIFY THAT:
*MISS. THALMA KABEYI ORADO*
of MOI UNIVERSITY, 0-509 NAIROBI,has been permitted to conduct research in *Nairobi County*

on the topic: *EFFECTIVENESS OF A SMARTPHONE WEB APPLICATION IN IMPROVING DIET QUALITY, PHYSICAL ACTIVITY AND NUTRITIONAL STATUS AMONG YOUTH IN NAIROBI COUNTY, KENYA*

for the period ending:
*24th April,2019*

.....
*Applicant's Signature*

Permit No : NACOSTI/P/18/89075/22239
Date Of Issue : 24th April,2018
Fee Recieved :Ksh 1000

.....
*Director General*
*National Commission for Science, Technology & Innovation*

**Appendix XI: Letter from Nairobi County Director of Education**

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref No: **NACOSTI/P/18/89075/22239**

Date: **24th April, 2018**

Thalma Kabeyi Oradu
Moi University
P.O Box 3900-30100
**ELDORET.**

**RE: RESEARCH AUTHORIZATION**

Following your application for authority to carry out research on ***"Effectiveness of a smartphone web application in improving diet quality, physical activity and nutritional status among youth in Nairobi County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **24th April, 2019.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

**DR. STEPHEN K. KIBIRU, PhD.**
**FOR: DIRECTOR-GENERAL/CEO**

Copy to:

The County Commissioner
Nairobi County.

The County Director of Education
Nairobi County.

**Appendix XII: Approval of Langata Sub-County Education Officer**

Republic of Kenya
MINISTRY OF EDUCATION
STATE DEPARTMENT OF BASIC EDUCATION

forwarded and no objection. Please accord her the necessary support 9/5/2018

Ref: RCE/NRB/GEN/1/VOL. 1

DATE: 8th May, 2018

Thalma Kabeyi Orado
Moi University
P O Box 3900-30100
**ELDORET**

**RE: RESEARCH AUTHORIZATION**

We are in receipt of a letter from the National Commission for Science, Technology and Innovation regarding research authorization in Nairobi County on "**Effectiveness of a smartphone web application in improving diet quality, physical activity and nutritional status among youth in Nairobi County, Kenya**".

This office has no objection and authority is hereby granted for a period ending **24th April, 2019** as indicated in the request letter.

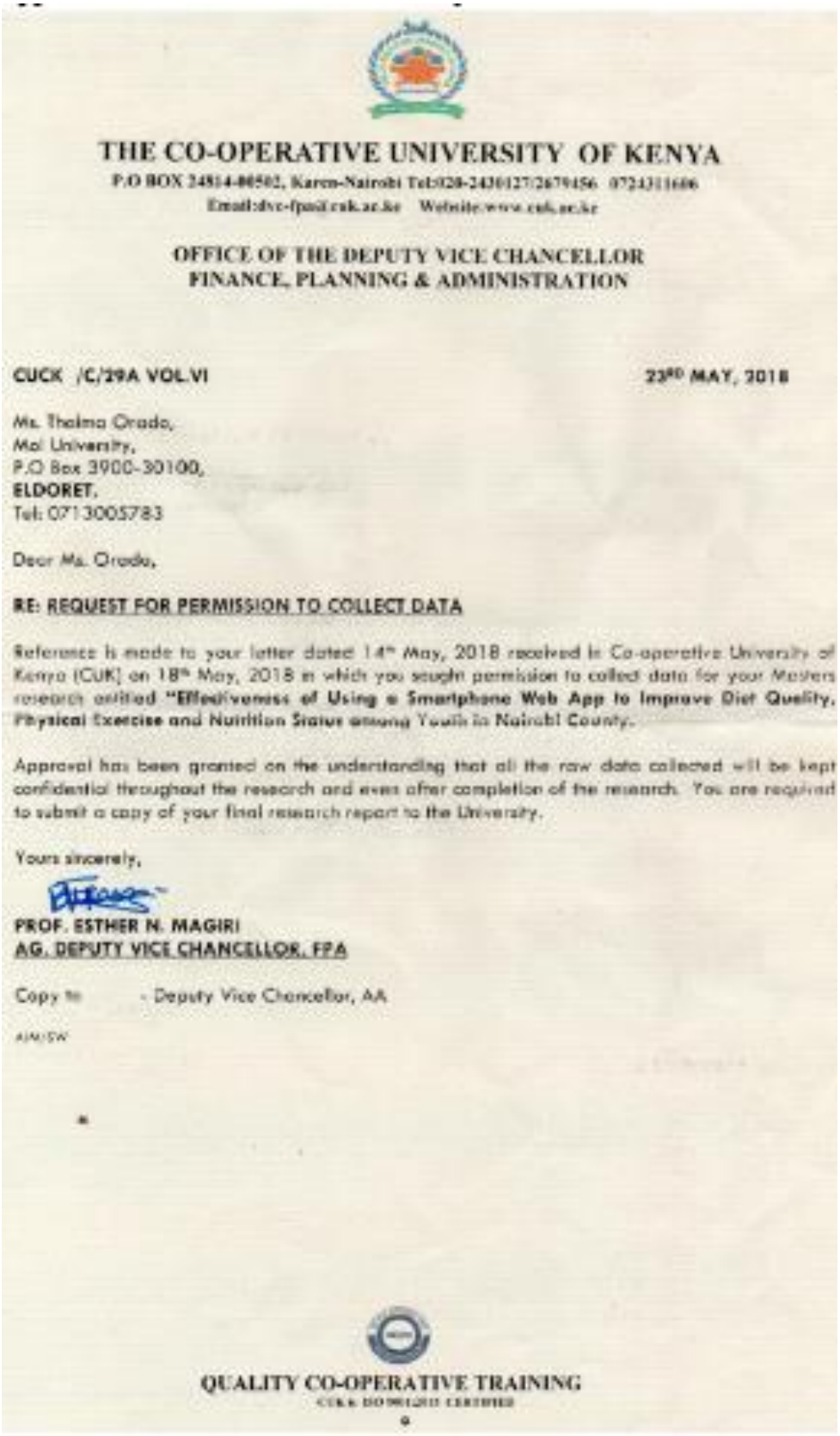
Kindly inform the Sub County Director of Education of the Sub County you intend to visit.

NAIROBI
08 MAY 2018

**MAINA NGURU**
**FOR: REGIONAL COORDINATOR OF EDUCATION**
**NAIROBI**

C.C
Director General/CEO
National Commission for Science, Technology and Innovation
**NAIROBI**

## Appendix XIII: Letters of Approval by Institutions



THE CO-OPERATIVE UNIVERSITY OF KENYA
P.O BOX 24814-00502, Karen-Nairobi Tel:020-2430127/2679456 0724311606
Email:dvc-fpa@cuk.ac.ke Website:www.cuk.ac.ke

OFFICE OF THE DEPUTY VICE CHANCELLOR
FINANCE, PLANNING & ADMINISTRATION

CUCK /C/29A VOL.VI 23RD MAY, 2018

Ms. Thelma Orodo,
Moi University,
P.O Box 3900-30100,
ELDORET.
Tel: 0713005783

Dear Ms. Orodo,

RE: REQUEST FOR PERMISSION TO COLLECT DATA

Reference is made to your letter dated 14th May, 2018 received in Co-operative University of Kenya (CUK) on 18th May, 2018 in which you sought permission to collect data for your Masters research entitled **"Effectiveness of Using a Smartphone Web App to Improve Diet Quality, Physical Exercise and Nutrition Status among Youth in Nairobi County.**

Approval has been granted on the understanding that all the raw data collected will be kept confidential throughout the research and even after completion of the research. You are required to submit a copy of your final research report to the University.

Yours sincerely,

PROF. ESTHER N. MAGIRI
AG. DEPUTY VICE CHANCELLOR, FPA

Copy to - Deputy Vice Chancellor, AA

AJM/SW

QUALITY CO-OPERATIVE TRAINING