DETERMINANTS OF IMPROVED WATER SUPPLY AND THEIR INFLUENCE ON DIETARY INTAKE, NUTRITIONAL STATUS AND MORBIDITY RATES OF PUPILS AGED 6-13 YEARS IN YATTA SUB COUNTY, KENYA

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Determinants of Improved Water Supply and their Influence on Dietary Intake, Nutritional Status and Morbidity Rates of Pupils Aged 6-13 years in Yatta Sub County, Kenya

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DECLARATION

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

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DEDICATION

I dedicate this work to my dear son Roy and daughters Fay and Fenny, whose coming into my life was a source of inspiration and made this study worth of completion.

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LIST OF ABBREVIATIONS AND ACRONYMS

AOAC	Association of Official Analytical Chemists
ASAL	Arid and Semiarid Lands
ASDP	Agricultural Sector Development Programme
BMI	Body Mass Index
CIA	Central Intelligence Agency
EMOP	Emergency Operation
FAO	Food and Agriculture Organization
FEWNET	Famine Early Warning Systems Network
FDA	Food and Drug Administration
FGD	Focus Group Discussion
GAM	Global Acute Malnutrition
GDP	Gross Domestic Product
GHA	Greater Horn of Africa
GOK	Government of Kenya
HDI	Human Development Index
HFIAS	Household Food Insecurity Access Scale

HGM	Holy Ghost Mission
ICC	International Association for Cereal Chemistry
ICF	Intermediate Care Facility
IFRC	International Federation of Red Cross and Red Crescent
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IQ	Intelligence Quotient
KDHS	Kenya Demographic and Health Survey
KFSSG	Kenya Food Security Steering Group
KII	Key Informants Interview
KNBS	Kenya National Bureau of Statistics
MDG	Millennium Development Goals (UN 2012)
ME	Metabolic Energy
NCHS	National Centre for Health Statistics
NCME	National Council on Measurement in Education
NEPAD	New Partnership for Africa's Development
NFE	Nitrogen Free Extract

NNC	National Nutritional Council
OXFAM	Oxford Committee for Famine Relief
PCD	Partnership of Child Development
SAM	Severe Acute Malnutrition
SPSS	Statistical Package for Social Science
SSA	Sub Saharan of Africa
UN	United Nations
UNDESA	United Nations Department of Economic and Social Affairs.
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children Fund
UNSCN	United Nations Standing Committee on Nutrition
USAID	United States Agency for International Development
USDA	United States Dept. of Agriculture
WOA	Water Operators Association
WFP	World Food Programme
WHO	World Health Organization

WESS	World Economic and Social Survey
WWAP	World Water Assessment Programme
WWDR	World Water Development Report
WWF	World Wildlife Fund

DEFINITION OF TERMS

Adequacy: A state of being sufficient for the concerned purpose. All the essential nutrients, fiber and energy in amounts sufficient to maintain health for the body.

Anthropometrics: These are physical measurements that reflect body composition and development such as height and weight.

Body Mass Index (BMI): This is an index of person's weight in relation to height determined by dividing the weight (in Kilograms) by the square of the height (in meters). This is an indicator commonly used to assess the nutritional status of adults and er children.

Dietary intake: Daily eating patterns of an individual, including specific foods and calories consumed and relative quantities.

Food consumption: Refers to the amount of food available for human intake as estimated by FAO, 2008.

Food consumption frequency: The type of food taken by an individual per day, week, month.

Food security: Is when all people at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Household: The smallest and most common unit of production, consumption and organization in a society. It includes all people or one person living in a house.

Malnutrition: An all-exclusive illness for poor nourishment that results from an inadequate diet or from failure to absorb or assimilate dietary elements, or from excessive intake of one or more nutrients.

Nutritional status: This is the health of a person as influenced by the quality of food eaten and the ability of the body to utilize the food to meet needs. This was determined by taking pupils anthropometrics measurements in order to determine Body Mass Index (BMI). Mid Upper Arm Circumference of each pupil was taken to establish the same.

Parent/caretaker: A person that is involved with provision and preparation of the pupil's food.

Prevalence: The total number of undernourished individuals in a given population at any one time.

24-hour recall: Is a structured interview intended to capture detailed information about all foods and beverages (and possibly, dietary supplements) consumed by the respondent in the past 24 hours, most commonly, from midnight to midnight the previous day.

Stunting: Low height-for-age, where HAZ < -2 Score, or <3rd percentile an indicator of Chronic malnutrition) (WHO, 2007).

Underweight: Low weight for age (Less than the 5^{th} percentile)

Water scarcity: Is the lack of sufficient available water resources to meet the demands of water usage within a region.

Water stress: Occurs when the demand for water exceeds the available amount during a certain period.

water crisis: Is a situation where the available portable, unpolluted water within a region is less than that region's demand.

Water shortage: The situation when water is insufficient water to meet the present and anticipated needs

Water deficit: It is a condition where water is insufficient with respect to demand.

ABSTRACT

In Africa, it is estimated that 25% of the population (about 200 million people) currently experience water stress, with more countries expected to face high risks in the future. In Kenya, three and a half (3.5) million people, including children are estimated to be in need of immediate humanitarian assistance mainly due to drought. Children living in Semi Arid regions are of the most vulnerable groups at risk of malnutrition, yet there is the scarcity of data concerning their dietary intake, nutritional status and morbidity rates in relation to the availability of improved water supply in Kenya. Located on the Eastern Coast of Africa, Kenya, a generally dry country with a humid climate, experiences severe water crisis. Global warming, is a major cause of severe droughts as well as floods. The contamination of drinking water, and a lack of investment in water resources have enhanced the crisis. Despite an improved water supply intervention, the population was still limited with potable water. The situation was particularly severe in Arid and Semiarid (ASAL) regions such as Yatta Sub County. The main purpose of this study was therefore to determine the effect of improved water supply on dietary intake, nutritional status, food consumption practices and morbidity rates of pupils aged 6-13 years in day mixed public primary schools. The dietary intake, food consumption practices, and morbidity rates of pupils in the schools with improved water supply were compared to those in the schools without improved water supply. Six schools were purposively sampled from public mixed day primary schools stratum. A sample of 400 pupils, aged 6-13 years, were randomly selected from six public schools in Yatta Sub County. A semi-structured questionnaire, observations, food proximate laboratory experiment, Key Informants Interviews (KII) and Focus Group Discussions (FGDs) were used to collect data. The assessment of dietary intake, nutritional status and morbidity rates of pupils in schools with and without improved water supply was carried out. The 24-hour dietary recall and Anthropometric measurements were carried out. World Health Organization (WHO) AnthroPlus was used to calculate the Body Mass Index (BMI), height for age and weight for age Z scores. Standard procedures of Association of Official Analytical Chemists (AOAC) were used to determine the food proximate chemical composition food that pupils fed on. Data was analyzed using Statistical Package for Social Science (SPSS) 2000, to determine the contribution of water supply on dietary intake, morbidity rates and nutritional status of pupils. Anthropometrical data was transformed into nutritional indices using EPI-INFO (2000) computer software. The indices were compared to World Health 0rganization (WHO) reference growth standards. The 24-hour dietary recall results were analyzed using Nutri-survey software to establish the total amount of selected nutrients in the meals consumed per day. Independent “t” test was done to compare the results between of the two groups that had water and the ones without. Improved water supply had an effect on dietary intake, nutritional status and morbidity rates of target group. Carbohydrates intake was below the threshold for pupils with (78.8%) and without (72.0%) improved water supply with respect to dietary intake. The same applied to iron intake where pupils with and without improved water supply stood at 86.2% and 81.1% respectively below the WHO threshold. However there was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to carbohydrate and iron intake. There was no significant difference between pupils with and without improved water supply with respect to proximate composition of food eaten by pupils. Of female pupils aged 11-13 years with and without improved water supply, BMI of 16.7 (Kg/m^2) and 14.5 (Kg/m^2) respectively were determined. There was no significant difference between pupils with and without improved water supply with respect to the mean BMI of female pupils. Of pupils aged 6 to 10 years with and without improved water supply, a mean height of 124.0 cm and 122.5cm respectively were recorded. There was a significant difference ($P < 0.05$) between pupils aged 6-10 years with improved water supply and those without improved water supply with respect to height. According to the findings, of pupils with and without improved water supply, 2.0% and 22.0% respectively, never cleaned their classrooms and toilets regularly. There was therefore, a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to cleaning of classrooms and toilets. According to the findings, of pupils with and without improved water supply, 41% and 46.5% respectively were sick. There was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to morbidity rates. In general, there was a significant difference ($P < 0.05$) between pupils aged 6-13 years with and without improved water supply with respect to dietary intake, nutritional and morbidity status in public primary day mixed schools in the Sub County. It was therefore recommended that the government through the Ministry of Water supply to the schools and households for use in order to curb malnutrition of school pupils. There is also need for the Ministry Of Education in collaboration with the Ministry of Agriculture to provide pupils who are unable to access food with adequate nutritious food.

CHAPTER ONE

INTRODUCTION

1.1 Background

Water is key to the achievement of food and nutrition security. Crops and livestock need water for their development and sustenance. Agriculture requires large quantities of water for food production. Water of good quality is also required for various production processes (UNDESA, 2014). But the right to water in the context of the right to food is a complex question. Past literature and considerable studies have demonstrated the effects of lack of appropriate water facilities, hand washing and hygiene practices on child health and development. A study by Ashish and Chioma, (2013) explored the impact of water treatment, hygiene, and sanitary interventions on improving child health outcomes such as absenteeism, disease infections, knowledge, attitudes, and practices and adoption of point-of-use water treatment. Another study was conducted in Kenya which utilized multiple intervention components involving water treatment, hygiene promotion, and sanitation to assess their impact on pupil absence (Freeman et al., 2012). However, a study on determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County, Machakos County Kenya, had never been carried out. Such study would determine the influence of water on Demographic and Social Economic characteristics, dietary intake, nutritional status and morbidity rates of pupils of the targeted age group and could, therefore, help to alleviate malnutrition of school-going pupils.

While drinking and cooking water is covered under this requirement, food production is not covered under the minimum needs in arid areas (UNDESA, 2014). There is increasing evidence that climate change is taking the greatest toll on poor and vulnerable people, and the impacts are largely caused by inequalities that result from hazards. This conclusion was reached a new report launched by the United Nations (WESS, 2016). Food and nutritional security are foundations of a decent life, a sound education and the achievement of the Sustainable Development Goals (UN, 2015).Water is the key element in the achievement of food and nutrition security.

Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. It affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water (Barbara, 2014). Water scarcity involves water stress, water shortage or deficits, and water crisis. While the concept of water stress is relatively new, it is difficult to obtain sources of fresh water for use during a period of time and may result in further depletion and deterioration of available water resources (Mohamed et al., 2014). Water shortages may be caused by climate change, such as altered weather patterns including droughts or floods, increased pollution, and increased human demand and overuse of water. A water crisis is a situation where the available potable, unpolluted water within a region is less than that region's demand (UNEP, 2013). According to Kummu et al., (2014), the possible insufficiency of land and water resources to meet the needs of humanity, particularly those of agriculture, is a pressing issue that is currently affecting roughly a third of the world's population.

Water scarcity is caused by climate change. Climate change is possibly the most significant environmental challenge of our time and poses serious threats to sustainable development in the world and more so in most developing nations (WESSS, 2013). Climate change affects ecosystems, water resources, food security and health status of people (Kummu et al., 2014). As such inter-related government policies must be designed to avoid conflicts in policy design and implementation. There is a direct link between climatic change and global food insecurity more so in developing countries where climate change compounded with poverty has exacerbated the impacts (Kipkoech et al., 2013). In order to address the challenges posed by climate change, it is necessary to examine the factors contributing to climate change and how such influence food production globally (Kipkoech et al., 2013).

Water stress is intensifying in regions such as China, India, and Sub-Saharan Africa, which contribute the largest number of water stressed countries of any region with an estimated 25% of the population affected (UNDESA, 2014). More than one in every six people in the world is similarly affected, meaning that they do not have access to adequate potable water (UNDESA, 2014). It estimated that up to1.1 billion people worldwide live in developing countries such as Kenya. An area experiences water stress when annual water supplies drop below 1,700 m^3 (cubic metres) per person. When annual water supplies drop below 1,000 m^3 per person, the population faces water scarcity, and below 500 m^3 per person "absolute scarcity" (UNDESA, 2014).

Tension is also very high in places where the equitable allocation of limited water resource is an issue. Bilateral agreements between nations in the Middle East, for example, have not arrived at fair access to equitable water supplies (Bigas, 2012). As a result, we are beginning to see some frightening convergences (Bigas, 2012). Agriculture currently uses 11% of the world's land surface, and irrigated agriculture uses 70% of all water withdrawals on a global scale. Without improved efficiencies, agricultural water consumption is expected to increase by about 20% globally by 2050 (WWAP, 2012).

The Horn of Africa is one of the most food-insecure regions in the world. More than 40% of people are undernourished, and in Eritrea and Somalia the proportion rises to 70%. The seven countries of the region – Djibouti, Ethiopia, Eritrea, Kenya, Somalia, the Sudan and Uganda – have a combined population of 160 million people, 70 million of whom live in areas prone to extreme food shortages (World Ecology Report, 2012). Kenya's population is about 40 million people and about 40% of this population is food insecure (Speca, 2013). Kenya's Northern, North-Eastern, coastal and south-central regions are severely affected by the current drought. Yield potential remains higher than actually achieved, with inadequate water and nutrients being the major limiting factors (Mueller et al., 2012).

The above status is aggravated by the fact that Agricultural production in Sub-Saharan Africa is particularly vulnerable to the effects of climate change, with rain-fed agriculture accounting for approximately 96 % of overall crop production (World Bank, 2015a). According to Elliott et al., (2014), irrigation adaptation limits for agriculture in southern Sub-Saharan Africa is due to climate-induced constraints in freshwater availability. Human responses to changes in one sector can also bring about impacts in other sectors. Expansion of agricultural areas to compensate for crop yield declines, for example, can come at the cost of terrestrial carbon sinks and other ecosystem services (Frieler et al., 2015) which are impacts of climate change, influencing improved water supply and their influence on dietary intake, nutritional status and morbidity rates of pupils aged 6-13 years in public day mixed primary schools in Yatta Sub County, Machakos Kenya.

Kenya covers an area of 581,309 km^2 and has a population of about 40 million (Central Intelligence Agency, 2012). Kenya is divided into seven ecological zones: Tropical Alpine, Upper Highland, Lower Highland, Upper Midland, Lower Midland, Lowland and Coastal Lowland. The country has an unusually diverse physical environment, including savanna grasslands and woodlands, tropical rain forest and semi-desert environments. There is a "low adaptive capacity"(GOK, "*Agricultural Sector Development Strategy*", 2010-2020. 2010) in Kenya's farming sector due to limited economic resources, heavy reliance on rain-fed agriculture, frequent droughts and floods, and general poverty (Odera et al., 2013). Drought influences the availability of water for crop production and other uses. The economies of most developing countries depend heavily on climate-sensitive sectors such as water, agriculture, fisheries, energy and tourism, climate change, therefore, poses a serious challenge to social and economic development in developing countries (Munang et al., 2013) like Kenya.

According to Githinji (2016), dietary practices influence the nutritional status of school aged children impact on their school performance. The ability of pupils to engage in school activities and to perform well in school is dependent on a diet that provides all the required nutrients. Child malnutrition has persisted in many developing regions of the world despite countless efforts towards its elimination (FAO, 2014). About 11.3% of world's population is malnourished, with the majority residing in Sub Saharan Africa and South East Asia (FAO, 2014). Under-nutrition is a direct causal factor of more than half of child mortality worldwide. Of the 6.3 million global children's death reported in 2013, 51% were attributed to under nutrition (Liu et al., 2015).

About 870 million people were estimated to have been under-nourished in the period 2010–2012. This represents 12.5 percent of the global population, or one in eight people. The vast majority of these 852 million lived in developing countries, where the prevalence of under-nourishment is estimated at 14.9 percent of the population. Under-nourishment in the world is unacceptably high (FAO, 2013). In spite of laudable improvements, an estimated 805 million people are under-nourished (FAO et al*.,* 2014). Of the 7.6 million deaths reported by the World Health Organization (WHO) in 2010, 64% were attributable to disease infectious including pneumonia, diarrhea and malaria which claimed the most lives (Liu et al., 2012). The determinants of children's nutritional status are multi-factorial (Black et al., 2013). The direct causes of under-nutrition in children are insufficient energy and nutrient intake, and recurrent infectious diseases (e.g. intestinal parasitic infection, malaria and diarrhea) (UNICEF, 2013). Factors that affect children's nutritional status indirectly include a lack of access to clean water and improved sanitation, inadequate hygiene, a paucity of health education and significantly, inappropriate agricultural practices and insufficiently healthy and diverse diets (World Bank, 2013).

According to the 2014 Kenya Demographic and Health Survey, four percent of children under five years of age and overall, 11% were underweight. This indicates that their weight was too low for their age. Stunting dropped from 35% in 2008-2009 to 26% in 2014 (KDHS, 2014). Wasting is a sign of severe malnutrition. Overall, one in five children were under- weight in Kenya. Stunting, wasting, and underweight are most common in rural areas and of families of lower socioeconomic status.

Under- nutrition of school-age children is a common problem in developing nations. It may turn out from a broad range of aspects like prenatal under-nutrition, deficiencies of macro and micronutrient, infection and possibly socioeconomic conditions (The Partnership of Child Development (PCD), 2013).This is attributed to the country relying on unreliable rain water and poor water supply to enhance good health. Malnutrition of school aged Children in Africa has been linked to morbidity, hygienic practices, dietary intakes and family socioeconomic status (Herrador et al., 2014; Mesfin & Berhane, 2015; Mwaniki & Makokha, 2013; Ndukwu, Egbuonu, Ulasi, & Ebenebe, 2013). In Kenya, 7% of urban children are underweight while 5.7% are overweight (KDHS, 2014)4). It was on the basis of the challenges affecting dietary intake, nutritional status, morbidity status of pupils mentioned above that the study sought to establish the determinants of improved water supply and their influence on pupils' dietary intake, nutritional status and morbidity rates of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County, Machakos County Kenya.

1.2 Statement of problem

It is estimated that between 2010 and 2012, 870 million people (about 12.5% of global population) were under-nourished and a majority of them were from developing countries e.g. 234 million were in Sub-Saharan Africa (FAO, WFP & IFAD, 2012) which includes Kenya. Malnutrition is the single greatest underlying contributor to child mortality at 53%.

The main immediate cause of malnutrition include inadequate food intake (WHO, 2010) which is attributed to climate change. Malnutrition mortality rates in northern Kenya exceeded emergency threshold prompting the Nutrition sector to seek emergency financial support to scale up interventions. The 2011 Nutrition Surveys indicated a deterioration of health in 11 northern Sub Counties where Global Acute Malnutrition (GAM) rates were recorded at 24% to 37% and severe acute malnutrition rated at 3-9%. The World Health Organization emergency threshold for GAM was 15%. Kenya has over 80% of the arable land located in water scarce areas with recurrent dry spells. The semi-arid areas support approximately 25% of Kenya's population. In Kenya, about 80 percent of the country's landmass is considered part of the ASALs, which receives little rainfall (less than 500 millimeters (mm) annually) and are at mostly low elevations (FEW NETS, 2013). Child Malnutrition; was associated with 54% of deaths in children in developing countries (WHO, 2013). Sub Counties such as West Pokot, Kitui and Mwingi in Kenya were exhibited heightened malnutrition caseloads. Incidences of Pellagra were reported in Makueni Sub County (Kibwezi Division) (International Federation of Red Cross and Red Crescent Societies, 2011). Many of these cases were also in Eastern region of Kenya where Yatta Sub County is included.

Yatta Sub County in Machakos County is located in the Semi-Arid Lands (ASAL) regions of Kenya and receives erratic rains of less than 500mm annually. As in the case of other drylands, the region has suffered from acute food shortage, forcing the community to rely on food relief, locally referred to as "mwolyo" as a survival strategy. The overdependence on food relief, however, has never provided the much needed solution for the chronic food shortage because the food aid always run out or is withheld due to various reasons. In spite of tough climatic conditions sub county hosts a large population distributed as indicated below (Table 1.1).

Table 1.1: Distribution of Yatta Sub county population by Division

Sub County	Population
Ikombe,	18,062
Katangi,	10,972
Kinyaata,	18,635
Kithimani,	25,974
Kyua	11,950
Matuu	27,794
Mavoloni	17,446
Ndalani	22,152

Source: information.go.ke: CDF allocation by sector and location 2003-6

The micro-catchments water harvesting technologies to address rainfall variability have been developed and promoted by public research and development institutions for the last two decades in these areas (Mumu et al., 2013). However, the region still relies on unreliable rainfall for food production and domestic uses. This eventually culminates in inadequate dietary intake and malnutrition and high morbidity rates of primary schools pupils.

According to most research findings, food shortage has been caused by inadequate or failure of rainfall. This implies that people rely mostly on rains and not on improved water supply (boreholes, water tanks) for food production and domestic uses (Binyam et al., 2014). However, the established improved water supply (boreholes, water tanks) have not been sufficient to sustain the Yatta Sub County community. As a consequence of this Irrigation has not a regular activity in much of Ukambani region (Machakos County in the past (Wayne, 2011) where Yatta Sub County is included. This has hence affected the dietary intake, nutritional status and morbidity status of pupils aged 6-13 years in public mixed day primary schools. This therefore impedes the realization of other pupils' rights such as the right to life and free primary education.

According to the 2014 KDHS, Severe acute malnutrition (SAM) is a major childhood health challenge in Kenya, especially during emergencies. Wasting, a measure of acute malnutrition was estimated at 4%, stunting at 26% and underweight at 11% (KDHS, 2014). This is attributed to huge regional variations such as in Arid and Semi-Arid Lands (ASAL), where food insecurity and drought have affected the population (UNICEF, 2012). Malnutrition cases in eastern Kenya are high. For example, stunting rates are extremely high (42%) in Eastern region of Kenya. Unless action is taken now to make agriculture more sustainable, productive and resilient, the impact of climate change will seriously compromise food production in countries and regions that are already highly food-insecure (FAO, 2016) like Yatta Sub County.

Previous studies indicate that the nutritional quality of key food crops could suffer under climate change (Myers et al., 2014).This is because vulnerability of agriculture to climate change has not always received the attention it deserves (FAO, 2016). Accordingly, the cascading impacts of climate change can now be attributed along chains of evidence from physical climate through to intermediate systems and then to people (Kirtman et al., 2014).Water supply is to encourage self-reliance in food production. Just having water in the sand dam area is not enough. Most crops are grown beyond the reach of 20 litre buckets or irrigation pumps and therefore people are forced to grow crops that are rain fed and the rains are unreliable (Wayne, 2011). As a result of food shortage and high morbidity rates caused by water scarcity, there has been interventions in Yatta Sub County to improve water supply.

1.3. Justification of the study

Yatta Sub County is a semi-arid region whose climatic conditions are not favourable to adequate potable water supply for domestic food production use. This therefore limits accessibility to adequate food and clean environment for pupils.

According to the literature, improved water supply had been established by the Government of Kenya in the previous six months or more in some areas. However, there was limited improved water supply to sustain adequate dietary intake, nutritional status, hygiene and sanitation. This culminated in malnutrition of household members, more so of the vulnerable group, including school going children, whose growth and development rate is high. Pupils in schools with improved water supply were compared to those without improved water supply.

The findings of the study can consequently be used by parents/caretakers, policy makers, Ministry of Education, Ministry of Agriculture, Ministry Health and researchers to improve water supply for domestic and irrigation use in order to curb inadequate dietary intake and malnutrition of school pupils and in semiarid regions as a whole. Findings can be used to develop appropriate strategies to improve water supply, culminating in improved dietary intake and the nutritional status of the school going pupils in the semi-arid regions. This would subsequently lead to improvement of pupils' health.

Findings of the study can be used to determine interventions to be put in place, seeking to improve water supply to enhance dietary intake and nutritional status of the school going pupils in Yatta Sub County, Machakos County Kenya. This can be achieved through putting in place adequate improved water supply systems to improve dietary intake hence alleviate malnutrition which is attributed to inadequate rain distribution in the semi arid regions of Kenya. This study advocates for determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of pupils in public mixed day primary schools in a semi-arid region, Yatta Sub County, Machakos County Kenya. The results of this study are pertinent to policy makers in the field of food security and livelihood sustainability.

1.4 Objectives

1.4.1 General objective

The main objective of the study was to determine the effect of improved water supply on dietary intake, food consumption practices, nutritional status, and morbidity rates of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County in Kenya.

1.4.2 Specific objectives

The specific objectives were:

1. To determine the social economic and demographic status of pupils aged 6-13 years in public mixed day primary schools with and without improved water supply and compare results.
2. To determine the effect of improved water supply on dietary intake of pupils aged 6-13 years in public mixed day primary schools with and without improved water supply and compare results.
3. To determine the effect of improved water supply on food consumption practices of pupils aged 6-13 years in public mixed day primary schools with and without improved water supply and compare results.
4. To determine the effect of improved water supply on the nutritional status of pupils aged 6-13 years in public mixed day primary schools with and without improved water supply and compare results.
5. To determine the effect of improved water supply on the morbidity status of pupils aged 6-13 years in public mixed day primary schools with and without improved water supply and compare results.

1.5 Hypothesis

1. Ho: Improved water supply in schools has no relationship with social economic and demographic status of school going pupils aged 6-13 years in primary day mixed schools in Yatta Sub County.
2. Ho: Improved water supply in schools has no relationship with dietary intake of school going pupils aged 6-13 years in primary day mixed schools in Yatta Sub County.
3. Ho: Improved water supply in schools has no relationship with food consumption practices of school going pupils aged 6-13 years in primary day mixed schools in Yatta Sub County.
4. Ho: Improved water supply in schools has no relationship with nutritional status of school going pupils aged 6-13 years in primary day mixed schools in Yatta Sub County.
5. Ho: Improved water supply in schools has no relationship with morbidity rates of school going pupils aged 6-13 years in primary day mixed schools in Yatta Sub County.

1.6. Scope and Limitation of the Study

The study focused primarily on addressing the determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub county, Machakos County Kenya. It was done through careful considerations that determines the effect of improved water supply in Arid and Semi Arid region, Yatta Sub County. The assumption was that the region is Arid and Semi Arid and improved water supply that had been put in place was over six (6) months.

This could therefore be evaluated with respect to dietary intake, nutritional status and morbidity rates for the study. Dietary intake, nutritional status and morbidity rates of pupils with improved water supply were analyzed and compared to those without improved water supply to assess the difference.

Given the constraints of time and resources, the study was not able to determine effect of improved water supply on food production and its impacts on nutritional status. The study was not also able to assess the food security at household level and food market prices and hence their impact on dietary intake, nutritional status and morbidity rates of the targeted group of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County was not determined.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Global Hunger Index

More than 2 billion people worldwide suffer from hidden hunger, more than double the 805 million people do not have enough calories to eat (FAO, IFAD & WFP, 2014). The Global Hunger Index (2013) indicates a severe food and nutrition security situation, (IFRI, 2013).The 2013 GHI states that hunger in South Asia prevails, with a hunger index of 20.7 making the region's status alarming. Closely behind is Sub-Saharan Africa with an index of 19.2. Sub-Saharan Africa, therefore, has, for the first time, achieved an index of under 20 points and has become ranked in the relatively better category of "serious". However, according to UN, 2017, more than 2.6 million Kenyans were severely food insecure as of May 2017 and this number was rapidly rising. The Horn of Africa experienced one of the worst hunger crises in recent past due to a prolonged drought (UN, 2017). High levels of malnutrition are also prevalent across the arid and semi-arid lands in Eastern Europe, the Commonwealth of Independent States, Latin America and the Caribbean the situation is considerably better, with values of 2.7 and 4.8 respectively (IFRI, 2013). Increasingly, Hunger is related to how land, water and energy are utilised. The growing scarcity of these resources puts more and more pressure on food security, and also triggers conflict (UNCCD, 2014).

The Global Hunger Index is a measure of the proportion of the undernourished as a percentage of the population. The following countries were not included due to lack of data: Afghanistan, Bahrain, Bhutan, Democratic Republic of Congo, Iraq, Myanmar, Oman, Papua New Guinea, Qatar, and Somalia (IFRI, 2013). Many countries where hunger is "alarming" or "extremely alarming" are especially prone to natural crises: the African Sahel experiences yearly droughts, violent conflict, and other natural calamities. The global environment has in the meanwhile become increasingly volatile (financial and economic crises, food price crises and so on) (IFRI, 2013). Interventions to fight hidden hunger and to improve nutrition focus on women, infants, and young children.By targeting these populations, interventions achieve higher rates of return by promoting health, nutritional status, and cognition later in life (Hoddinott et al., 2013). There is, therefore, need to build resilience in the livelihoods of communities living in drylands, by introducing an ecosystem services perspective as the conceptual framework to explore the resilience offered by trees (De, 2014).

2.2 Water supply in arid and semiarid regions

Most drylands are found in the developing countries where the majority of the world's poorest, food insecure, and most marginalized communities live. Drylands receive very little attention and investment in time from researchers (Solh et al., 2014). There are some areas where the daily water consumption per person is of 25–30 liters while the World Health Organization recommends 120 liters per capita per day (World Bank, 2016). For instance, although the bulk supplier is Palestinian, much of the water resources in the West Bank are controlled by Israel. The demand is particularly acute in summer time: in Hebron, the municipality is able to deliver water only once every 21 days, which generates discontent of the population who are less willing to pay for such poor service (World Bank, 2016). Most studies cite population growth as the principal driver of increases in the global demand for water. Although there are uncertainties surrounding future population projections, research shows that the world population is likely to grow by 30% between 2000 and 2025 and by as much as 50% between 2000 and 2050 (United Nations Secretary-General's High-Level Panel on Global Sustainability, 2012). A study of 92 developing countries (Vaux, 2012) shows that, as higher incomes drive improvements in diets around the world, as much as an additional 5,200 cubic kilometres of water may be needed annually for agriculture alone by 2050.

In developing countries, such as those within Africa, agriculture accounts for more than 80% of water consumption (UNDP, 2014). This is because, it takes about 3,500 litres of water to produce enough food for the daily minimum of 3,000 calories, and food production for a typical family of four takes a daily amount of water equivalent to the amount of water in an Olympic-sized swimming pool (UNDP, 2014). Majority of Africa remains dependent on an agricultural lifestyle and 80% to 90% of all families in rural Africa rely upon producing their own food (FAO, 2013). Water scarcity translates to a lot of communities not tapping into their irrigation potential (FAO, 2013) and according to the UN Economic Commission for Africa and New Partnership for Africa's Development (NEPAD), "irrigation is key to achieving increased food security. With less than a third of the continent's potential using irrigation, most of rural African agricultural production that is important for economic development and for attaining food security (FAO, 2013) is low. Efforts to double the area of Africa's irrigated land is currently high on many political agenda, which can potentially be addressed through markets, commodity selection, ownership, land tenure, reliable water storage, and international agreements.

Water scarcity already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water (UNDESA, 2013).Water scarcity involves water stress, water shortage or deficits, and water crisis. Freshwater resources of India are getting fast degraded and depleted from the changing climate and pressure of fast rising population. Changing intensity and seasonality of rainfall affect quantity and quality of water (Nansen Environmental Research Centre India, 2016). The continuously growing global water scarcity and the evidences of climatic changes require a refocus on reliable and sustainable water supplies, especially in arid and semi-arid regions, being the most water-deprived regions in the world (Yehuda, 2015). This is the scenario that one encounters in a place such as Yatta Sub County where sourcing reliable and sustainable water supply for food production and household use is a challenge.

Water shortages may be caused by climate change, such as altered weather patterns including droughts, floods, increased pollution, increased human demand and overuse (WWF, 2013). This uncertainty over the availability of groundwater resources and their replenishment rates poses a serious challenge to their management and in particular to their ability to serve as a buffer to offset periods of surface water scarcity (Vander Gun, 2012). Implications of population growth and climate change for the world's water supply will likely pose daunting challenges. Most evidence suggests that the combination of population growth and economic development drives significant growth in agriculture and agricultural water use (Marianela et al., 2013). These concerns extend to all countries which must develop additional sources of water for agriculture. They include countries which will expand agriculture in response to increase in demand for agricultural products (virtual water) and they extend especially to the countries which occupy arid and semi-arid lands. Not only do floods and droughts disproportionately impact the poorest and the marginalized in any society, but they also exacerbate vulnerabilities and widen social inequality while at the same time slowing or even reversing economic growth and development (Schuster, 2015). Failure to provide environmental water could itself lead to a reduction in global food supplies. Over 80% of Kenya's land mass is defined as Arid and Semi Arid lands (ASALs). These are homes to nearly one third of the population and 70% of the livestock herd. These areas are characterized by low and erratic rainfall (Fitzgibbon, 2012).

A large proportion of the rural population in Kenya is still using unimproved water sources. According to the Kenya Annual Sector Review 2012-2013, the difference between water access in rural and urban areas is still very high, with 58% of people in rural areas still relying on unimproved sources such as streams, lakes and ponds for their domestic water supply.

2.3 Effect of climate change on dietary intake of pupils

Climate change is a major public health threat that is exacerbated by food production. Climate change is already widely recognized as a threat to agricultural production (IPCC, 2014), but the range of impacts to food systems is not yet fully understood (Acharya et al., 2014). Although the causes of such vulnerability are multi-dimensional, they are primarily due to widespread poverty, food insecurity, recurrent droughts, land degradation, inequitable land distribution and overdependence on rain-fed agriculture (Notenbaert et al., 2013; Lo´pez-Carr et al., 2014). Deficiencies may worsen due to increasing atmospheric carbon dioxide (CO_2), which not only drives climate change but also lowers crop concentrations of zinc and iron (Myers et al., 2014).

In Turkana County, one of the poorest County in Kenya with an estimated 87.5% of the population living below the absolute poverty line (Kenya National Bureau of Statistics KNBS, 2013), the situation is exacerbated by the harsh climatic environment. This therefore, affects dietary intake of pupils. Grace et al., (2012) found that variability in climate across Kenya was correlated to malnutrition. Further, diversifying incomes and loss of landscape complexity were linked to lower nutritional status in Brazil (Adams et al., 2013).

2.4 Food and Nutrition Security

Food security exists when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life. It requires the meeting of four pillars: availability, access, utilization and stability (FAO et al., 2012).This is not the case in Kenya and, specifically, in Yatta Sub County. Food availability refers to the physical existence of food, either from own production or the markets. Globally, food and nutrition insecurity remains a significant challenge. The vast majority of hungry people (827 million) live in developing countries, where 14.3 percent of the population is undernourished (FAO, 2013).

Asia has the largest number of hungry people (over 500 million) but Sub-Saharan Africa has the highest prevalence (24.8 percent of population (FAO, 2013). Food access on the other hand is ensured when all households and individuals have sufficient resources to obtain appropriate foods for a nutritious diet. It is dependent on the level of household resources – capital, labour, knowledge of nutrition and of food prices. According to FAO et al., (2012), the prevalence of under-nourishment is an indicator of the relative adequacy of food availability across the population and can serve as a useful proxy for food security at the national level. However, it is statistically complex to calculate given that it is largely dependent on the national capacity to generate reliable data on a regular basis and is not a direct indicator of access to food at the household or individual level. The same is true of composite measures of hunger like the Global Hunger Index, composed of indicators of undernourishment, child underweight and child mortality (Grebmer et al., 2012).

Food security is also affected by the fact that most Kenyans subsist on diets based on staple crops (mainly maize) that are lacking in nutritional diversity. Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individuals. Lack of access to adequate and diversified diet results in various forms of nutritional deficiency (FAO et al., 2012). The greater threat to both near and long-term sustainability of food systems may be freshwater scarcity, which is already constraining agricultural productivity in many areas (Schewe et al., 2014).

In situations where any of the pillars is compromised such as through increased unemployment and declining wages that erode purchasing power, people find ways to cope. For example, in Inuvik, Northwest Territories, Canada, community food programs including a food bank, a shelter, and a soup kitchen (called Soup and Bannock), are available to local Inuit community members (Ford et al., 2013).

The food security outlook in Africa is worrisome, as Africa's population is expected to increase from 1.01 billion in 2009 to 2 billion in 2050 if current demographic conditions remain constant. They are growing at 2.4 percent per year and are projected to reach at least 2 billion by 2050 (Carl, 2012).

More than 60% people of Kenya live below the poverty line (less than $1.25 a day or unable to afford to buy food providing a daily intake of 2,100 kilocalories) (World Bank, 2013). These people have few or no assets. Many of them survive by cultivating small pieces of land which are often inadequate to sustain a living. Kenya, also, faces the classic food price dilemma. Food price instability in the country, which is frequently identified as a significant obstruction to smaller productivity growth and food security (Mohajan, 2013).

2.5 Causes of Food Insecurity

The world produces enough food for the entire global population of 7 billion people. However, one in eight people on the planet goes to bed hungry every night. In some countries, one child in three is underweight (WFP, 2012). Drought is one of the most common causes of food shortages in the world. In 2011, recurrent drought caused crop failures and massive livestock losses in parts of Ethiopia, Somalia and Kenya. In 2012 there was a similar situation in the Sahel region of West Africa (WFP, 2012). There can be many causes of food insecurity. Some causes are short term and are brought about by natural destructive phenomena, for example, when floods, cyclones, droughts, or locust plagues destroy crops and food stores. There are many inter-related issues causing hunger, which are related to economics and other factors that cause poverty. They include land rights and ownership, diversion of land use to non-productive use, increasing emphasis on export-oriented agriculture, inefficient agricultural practices, war, famine, drought, over-fishing, poor crop yields, etc. This section introduces some of these issues (Anup, 2014).

The causes of food insecurity and malnutrition in Africa are diverse, multi-factorial and interlinked. Poverty and food shortage are the main catalysts of food insecurity in the world; unfortunately, they occur in a vicious cycle. In 2004, 121 million sub-Saharan Africans lived on less than a meagre US$ 0.50 a day (World Bank, 2012). People living on less than US$ 1.00 per day are unable to pay the prices they would need to buy all of the staple food they require. As a result of this, meat and fish consumption for the many poor Africans is a luxury. Although the share of the population living in extreme poverty in Sub Saharan Africa declined by more than 10% to 48% between 1999 and 2008 (World bank, 2012), there still occurs food insecurity.

2.6 Consequences of Food Insecurity

Famine and hunger are both rooted in food insecurity. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger; ensuring food security presupposes elimination of that vulnerability (Ayalew et al*.,* 2013). Children are more vulnerable to the consequences of food insecurity and malnutrition because of their physiology and high calorie needs for growth and development. Malnutrition is the underlying cause of death of more than 2.6 million children each year. This figure is a third of deaths of children aged under the age of five years and a third of total child deaths worldwide (WFP, 2012). Some 795 million people in the world do not have enough food to lead a healthy active life. That is about one in nine people globally (FAO, 2015). The vast majority of the world's hungry people live in developing countries, where 12.9 percent of the population is undernourished. 66 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone (WFP, 2012). Regarding economic consequences, food insecurity debilitates society by increasing mortality, disease and disability. It inflates the direct economic costs of coping with the health impacts and enormous reduction in human potential and economic productivity, brought about by hunger and malnutrition (Mentan, 2014).

Similarly, hungry children make poor students and are prone to drop out of the educational system. Hungry and malnourished adults are unable to be fully productive workers and are more likely to be ill, increasing the burden on the often overstretched health systems (UNDP, 2012). The aggregate costs of food and nutrition insecurity in Africa impose a heavy burden on efforts to foster sustained economic growth and improve the general welfare. Of the 30 countries ranked at the bottom, only Afghanistan and Haiti are outside the region. (UNDP, 2012). Once solutions can be proffered to the food insecurity and malnutrition challenges in SSA, under-development will not be a significant issue on the continent. Africa's food and security situation should be seen as a global problem with severe consequences.

The fight to combat food insecurity in Africa is a tough but not an insurmountable one. Future efforts will require both active Governments, multilateral and bilateral donors pledging long-term funding to commit to national efforts to end famine and food insecurity at a level that is commensurate with the scale of the problem (Thomas & Zuberi, 2012). Only then can Africa overcome its food security challenges. Reducing food insecurity and malnutrition is a significant challenge for many developing countries. Kenya is one of the African countries where millions of people are still undernourished (FAO, 2013).

2.7 Dietary intake of pupils in Kenya

In developing countries, the diets of school-age children and adolescents are very limited in diversity. The pattern is characterized by minimal intake of animal foods, fruits and vegetables and high consumption of calorie-rich processed foods. The problem is further exacerbated by the replacement of traditional diets with Western diets in developing countries. Consequently, many children have an inadequate energy intake and are deficient in micronutrients (Ochola & Masibo, 2014).

Data on dietary intake are critical for guiding health and nutritional interventions for children and adolescents (Ochola & Masibo, 2014). The school age and adolescent years comprise a dynamic period of growth and development that forms the basis for health and productivity in later life (Ochola & Masibo, 2014).

This review of the dietary intake of schoolchildren and adolescents (aged 6–19 years) aimed to characterize the dietary patterns and assess the adequacy of nutrient intake to identify the effects on public health and nutrition (Ochola & Masibo, 2014). Adolescents constitute 18% of the world's population, with the vast majority (88%) living in developing countries (UN, 2014). Similar to the previous studies stated above, the adolescent school children in developing countries were targeted however determinants of improved water supply and their influence on the dietary intake, food consumption practices, nutritional status and morbidity rates of children were not carried out and hence this study.

2.8 School Feeding Programme

School Feeding Programmes (SFPs) were implemented in Kenya from the 1980's onwards with varying degrees of success. Between 2001 and 2002, the USDA provided 70,900 MT of food aid to Kenya in support of the Global Food for Education Initiative (WFP, 2013)**.** The donation enabled WFP to expand existing school feeding operations in the Arid and Semi-arid drought and famine stricken Counties in the country. The expansion targeted an additional one million pre-primary and primary school children. In 2002, the total number of children assisted in school feeding programs across Kenya totaled to 1.7 million (WFP, 2013)**.**

The programme started with one school, in response to a severe drought that Kenya experienced in 2002, eventually the program was grown to include 34 schools and approximately 18,000 students fed daily. Based on the World Health Organization's minimum requirement for basic nutrition, Kenyan school children's lunch which consists of maize and beans cooked with some oil was served. Locally, in Yatta and Eastern Kenya, this is known as Isyo, (WHO, 2015). However, malnutrition and resultant poor health still keep pupils away from attaining their full potential especially in developing countries such as Kenya, and specifically in Arid and Semi Arid regions.

Kenya is a low-income, food-deficit country with an aggregate household food security index of 71.7, ranking it 51 out of 61 countries (WFP, 2013). It has a population of 29 million (1997) and a per capita Gross Domestic Product (GDP) of $281(WFP, 2013). In 1997, 43% of Kenya's population was living in absolute poverty. The incidence of poverty is highest in the Arid and semi-arid land areas. In 1997, the national average human development index ranked Kenya 134 out of 175 countries (WFP, 2013).

Nutritional deprivation was found to be much more prevalent in Arid and Semi-Arid Land areas. It is not uncommon for only one meal to be prepared daily and for children to go to school without eating breakfast. Poor nutritional status increases the risk of frequent illness and the likelihood of poorer performance and grade repetition at school (WFP, 2013).

Many of the schools supported through the school feeding program have considerable problems accessing clean water, adequate fuel supplies, and fruits and vegetables to supplement the basic school feeding program. The long-term objective is to promote universal education for socio-economically disadvantaged and nutritionally vulnerable children, especially girls, in pre-primary and primary schools, in targeted Arid and Semi-Arid land areas (WFP, 2013). Reasons behind the programme are: "that the average Kenyan's income is about $1/day, the average Kenyan eats one meal per day, the typical dropout rate in Kenyan elementary schools is 40%-50%, the vast majority of students normally quit schooling after 8 years of primary school education, when free education ends. With our first pilot school, the dropout rate went from 46% to 1% once we started providing meals" (http://kenyakidscan.org/feeding/). The previous studies as stated above have looked into the challenges facing school feeding programme in Kenya. It is, therefore, important to go beyond and determine the root cause of the challenges faced and putting measures in place to alleviate inadequate dietary intake of pupils in public primary schools and, more so, in Arid and semi Arid regions of Kenya.

2.9 Composition of Food and Proximate Composition Analysis.

Food comprises of chemical molecules. Chemical composition may be determined in the laboratory. The term "food" refers to the broad range of edible materials that comprise the essential body nutrients required for life and growth, such as proteins, carbohydrates, fats, vitamins, or minerals. Composition of food (Rahmawati, 2013). According to National Institute of Health, 2016, the proximate composition of foods includes moisture, ash, lipid, protein and carbohydrate contents.

2.10 Factors that influence Dietary practices and Nutritional status of pupils

Nutrition-sensitive and sustainable agriculture has found growing conceptual support (FAO, 2013); however, agricultural interventions within complex and dynamic ecological and socioeconomic environments typically fail to demonstrate significant improvement in direct measures of nutrient status (Ruel et al., 2013). Causes of malnutrition, death, impaired learning ability and other disabilities are therefore multi-sectoral, embracing food, health and caring practices. Malnutrition impairs a learning ability and deaths are the result of interlinked causes at the different levels and depths. These are immediate causes, underlying causes at the household level and basic causes at the society level. Implications of malnutrition include weight loss and faltering growth that eventually impair learning ability and school performance.

Long-term malnutrition is associated with impaired mental development and more susceptibility to illness and diseases-leading to impaired learning ability. Stunted growth is one of the main long-term effects of malnutrition in children (King, 2013). The agricultural sector is still the backbone of Kenya's economy and economic development is dependent on improvement in agriculture. The main staple food in Kenya is maize, which accounts for about 65% of total staple food caloric intake and 36% of total food caloric intake. Kenya is the largest food and agricultural products importer in Eastern Africa (Mohajan, 2014). The overall effect of climate change on yields of major cereal crops in the African region is very likely to be negative, with strong regional variation (Niang et al., 2014). Dietary diversity as a practical indicator of nutrient adequacy may be the most satisfactory proxy for nutritional quality both in comparing differences in available food resources and in response to dietary change (Ruel et al., 2013) but requires evaluation in relation to improved water supply interventions. Despite established improved water supply, people in Arid and Semi Arid regions of Kenya still rely on rains instead of improved water supply to curb inadequate dietary intake.

2.11 Nutritional status of pupils in Kenya

The worldwide variation of the prevalence of low height-for-age is considerable, ranging from 5% to 65% of the less developed countries (WHO, 2015). In Kenya, more than 10 million people are chronically food insecure (Haradhan et al., 2014) culminating in malnutrition being the single greatest contributor to child mortality at 53%. According to Githinji et al. (2016), school age is a critical period during which adequate nutrition is considered an important factor that affects learning capabilities.

Studies conducted in most developing countries reveal that malnutrition (underweight, overweight) is common of school going children (Mwaniki et al., 2016). Research has shown that nutritional status affects children's development. Nonetheless, majority of these studies have focused primarily on nutritional status of school-children as general surveys without correlating the findings on determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of school going children in Arid and Semi Arid regions of Yatta Sub County, Kenya.

2.11.1 Nutrition and Food Security

Food insecurity, is a situation of "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways", according to the United States Department of Agriculture (USDA, 2013). Famine and hunger are both rooted in food insecurity. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger; ensuring food security presupposes elimination of that vulnerability (FAO, 2013). This is the case in Kenya especially in semi arid regions where inadequate food availability is caused by limited water supply for food production.

School feeding programs have been defined by the World Bank as "targeted social safety nets that provide both educational and health benefits to the most vulnerable children, thereby increasing enrolment rates, reducing absenteeism, and improving food security at the household level (World Bank et al., 2012). School feeding in low-income countries often starts through funding by international organizations such as the United Nations World Food Programme or the World Bank or national governments through programs such as the McGovern-Dole International Food for Education and Child Nutrition Program. However, some governments have first started school-feeding programs and then requested the help of these organizations and programs. Additionally, many countries have "graduated" from their dependency on foreign assistance by reshaping their school feeding programs to be country-led and self-supported (Bundy, 2013).

According to the United Nations World Food Programme, 66 million primary school-age children go hungry every day, with 23 million of these children living in Africa alone. (WFP, 2013). Furthermore, 80% of these 66 million children are concentrated within just 20 countries. Additionally, 75 million school-age children (55% of them girls) do not attend school, with 47% of them living in sub-Saharan Africa (WFP, 2013). Thus, the need to reduce hunger while increasing school enrolment in these children is evident, and school feeding programs have been developed to target this multifaceted problem. Overall, the amount of kilocalories in a child's diet is expanded when they are given nutritional resources that they would otherwise have little to no access to. By increasing the amount of nutrition a child receives at school, that child's family's nutrition status also increases as their family demand and requirement for food is decreased (Lawson et al., 2012).

The link to local agricultural production can help the sustainability of these programmes and create predictable and structured markets for local produce. This approach has been identified as one of the critical elements in transitioning to sustainable programmes.

Several more developed countries (e.g. Brazil, Chile and Scotland) have demonstrated the effectiveness of purchasing school food locally to feed children better and to stimulate the local economy (WFP, 2013).This is not the case in semi-arid regions in Kenya where water is not sufficient for irrigation, aimed at food production to alleviate food insecurity of pupils. Irrigation can be very important to boost crops production in countries with low crop production and consumption (Giordano & Fraiture, 2014).

2.12 Water supply and the morbidity status of pupils in semi-arid regions

Children are the most visible victims of undernutrition. Black et al. (2013) estimated that undernutrition in the aggregate including fetal growth restriction, stunting, wasting, and deficiencies of vitamin A and zinc along with sub optimum breastfeeding is a cause of 3·1 million child deaths annually or 45% of all child deaths in 2013. Kenya is classified as one of the water-deficient countries in the world and irrigation-based farming is still limited which is attributed to children's morbidity rates. No effort has been made to improve the water supplies in terms of sinking boreholes to provide water for domestic use. Water resources are unevenly distributed in space and time. About 56% of all the country's water resources are in the Lake Victoria basin and the water of the lake cannot be used for either irrigation or drinking in remote areas (Mohajan, 2014).

Stunting refers to reduced growth rate whereby height for age value is less than -2 standard deviations of the WHO child Growth Standards median (WHO, 2007). A child is moderately wasted when the weight for height is less than –2 SD from the mean. If the child weight for height is less than 70% of the median and is equal to a standard deviation score of –3SD then the child is severely wasted (WHO, 2007). In Kenya, the national prevalence of stunting (too short for age, showing chronic malnutrition) is 26%, wasting (too thin for height showing acute malnutrition) is 4 %, and underweight (too thin for age showing acute and chronic malnutrition) is 11% (KDHS, 2014). Malnutrition is the single greatest contributor to child mortality at 53% (Mohajan & Kumar, 2014).

Malnutrition mortality rates in northern Kenya exceeded emergency threshold prompting the Nutrition Sector to seek emergency financial support to scale up interventions (UNICEF, 2012). The 2011 Nutrition Surveys indicated a deterioration in health in 11 northern districts where Global Acute Malnutrition (GAM) rates were recorded at 24-37 per cent and severe acute malnutrition rated at 3 to 9 per cent. The World Health Organization emergency threshold for GAM is 15 per cent. Although malnutrition levels could mainly be attributed to lack of access to adequate nutrition, factors such as poor hygiene practices and disease, occasioned by limited access to safe water are also contributing to the record malnutrition levels (International Federation of Red Cross & Red Crescent Societies, 2011). Sub Counties such as West Pokot, Kitui and Mwingi in Kenya exhibited heightened malnutrition caseloads. Incidences of Pellagra were reported in Makueni District (Kibwezi Division) (International Federation of Red cross & Red Crescent Societies, 2011).

According to UNICEF (2012), Government of Kenya data rates of stunting of children were much higher in Eastern Province (42%), compared with Nairobi (29%). Vitamin A supplementation coverage is 66% and iodized salt consumption is 67.6%. Yatta Sub County too belongs in the first category of Eastern Province. Kenya has, in the recent past, experienced a rise in diet-related non-communicable diseases, such as cardiovascular, diabetes, cancers, kidney and liver complications that are attributed to the consumption of foods low in fibre and high in fats and sugars. Due to these diseases, premature death is increasing and reducing the quality of life. The proportion of women aged 15–49 who are overweight and obese has increased from 23% in 2003 to 25% in 2008–09 (National Nutrition Action Plan, 2012-2017, 2012).

The Government of Kenya (GOK) has developed the food and nutrition security policy to address nutrition security in the country and which places nutrition central to human development in the country. The GOK is harmonizing actions to improve nutrition with ministries and external organizations. GOK committed to spend Ksh.6 billion ($70 million) over the next five years (2013–2015) to scale up nutrition.

National Nutrition Action Plan defines cost effective and high impact activities, and includes a strategic focus on increasing the demand and use of research to influence policy and practice.International Medical Corps operates five emergency nutrition programmes in northern Kenya, where severe drought and increasing instability from neighbouring Somalia have led to serious food shortages. The GOK developed 11 strategic objectives that need to be addressed in order to realize the goal of promoting and improving the nutrition status of all Kenyans (National Nutrition Action Plan, 2012-2017). The solutions to malnutrition are practical, basic and have to be applied at scale and prioritized in the national development agenda (National Nutrition Action Plan, 2012-2017, 2012).

2.13 Magnitude of Malnutrition

It was estimated that between 2010 and 2012, 870 million people (about 12.5% of global population) were undernourished and majority of them were from developing countries e.g. 234 million were in Sub-Saharan Africa (FAO, WFP, & IFAD, 2012). Despite the fact that prevalence of stunting and underweight of children declined globally since 1990, the overall progress is still inadequate and millions of children remain at risk (UN, 2015). One in four of the world's children are stunted. In developing countries the proportion can rise to one in three (Public Health Nutrition, 2012). 66 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone (WFP, 2012) and therefore WFP calculates that US$3.2 billion is needed per year to reach all 66 million hungry school-age children (WFP, 2012). Contributing to more than half of deaths in children worldwide; child malnutrition was associated with 54% of deaths in children in developing countries in 2001 (WHO, 2013).

More than one third of the world's malnourished children live in India. Low productivity not only gives them low pay that traps them in a vicious circle of under-nutrition but also brings inefficiency to the society, especially in India where labour is a major input factor for economic production (WHO, 2012).

In 2010, the Food and Agriculture Organization estimated that 925 million people suffered from hunger. This is symptomatic of a global structural problem threatening the achievement of the Sustainable Development Goals (SDG) Development Goal (MDG) to halve hunger by 2015 (UN, 2015).Kenya’s northern, north-eastern, coastal and south-central regions are severely affected by the current drought. More generally, all arid and semi-arid areas – which constitute more than 80 per cent of Kenya’s land mass – are prone to drought and its impacts are felt across the nation (Fitzgibbo, 2012).

Kenya’s key economic sectors, such as Agriculture, Livestock and Tourism, are all climate-sensitive. The economic, social and environmental impacts of drought are huge in Sub Saharan of Africa (SSA) and the national costs and losses incurred threaten to undermine the broader economic and development gains made in the last few decades in the region (Bekele et al., 2014). Malnutrition therefore, continues to be an important public health problem in Kenya. All in all, there has been a marked reduction in malnutrition since 2008/9; Stunting has decreased from 35 percent to 26 percent, wasting from 7 percent to 4 percent, and underweight from 16 percent to 11 percent (KDHS, 2014). However according to Chitima et al., (2017), Children living in rural areas in Kenya are particularly vulnerable to stunting, wasting and underweight. Higher levels of undernutrition have been found especially in dry seasons compared to wet seasons, meaning nutritional intake is highly dependent on rainfall (Chitima et al., 2017) in arid and semi arid regions of Kenya. Malnutrition therefore, remains a challenge in these regions of Kenya.

2.13.1 Effects of Malnutrition

Malnutrition is a condition that develops when one's body does not get enough nutrients to function properly. Malnutrition can be caused by a lack of food or an unbalanced diet that's missing or insufficient in one or more nutrients (King, 2013). The World Health Organization says that malnutrition affects about 792 million people worldwide. At least a third of them are children.

Apart from the cost of human suffering, the UN SCN 5th report on the world nutrition situation identified nutrition as the foundation for development and malnutrition as an obstacle to human development. This culminates into inflicting irreversible damage on individuals early in life and imposing large economic and social losses on countries for years to come (UNDP, 2012).

Stunting is one of the main long-term effects of malnutrition in children. Malnutrition can hinder a child's ability to grow normally, leaving both his height and his weight under normal when he's compared with children of the same age. Stunted growth can be permanent, and a child may never achieve normal height or body weight if he is chronically malnourished (King, 2013). Kwashiorkor is an acute type of protein-energy deficiency that is common in children who are malnourished. Kwashiorkor differs from marasmus in that calorie intake can be sufficient, but protein intake is severely restricted. Symptoms of kwashiorkor include discoloured, brittle hair that has a copper sheen, rashes, water retention, a distended belly caused by bloating, an enlarged liver and apathy. Severe cases of kwashiorkor are rare in the United States. If left untreated, this condition leads to coma and death (Public Med Health: Kwashiorkor, 2012).

According to the KDHS, (2014), Machakos County was ranked as one of those with high rates of malnutrition of children. This does not mean that there is no intervention in the region. According to Chitemi et al., (2017), each nutritionally vulnerable group has different nutritional needs and requirements and therefore, unique interventions must be implemented. Under-nourishment reduces the immune response of the population, resulting in a significant amount of hours lost in terms of performance (Hammonda et al., 2012).

2.14 Research Gap

Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. It already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water (UNDESA, 2013. According to most research findings, food shortage has been caused by inadequate or failure of rainfall. This implies that people rely mostly on rains and not on improved water supply (boreholes, dams, water tanks) for food production and domestic use (Binyam et al., 2014) including hygiene and sanitation. According to Mumu et al., (2013), the micro-catchments water harvesting technologies to address rainfall variability have been developed and promoted by public research and development institutions for the last two decades in these areas. However the region still relies on unreliable rainfall for food production, hygiene and sanitation.

According to Ochola and Masibo (2014), the review of the dietary intake of school children and adolescents (aged 6–19 years) was aimed to characterize the dietary patterns and assess the adequacy of nutrient intake to identify the effects on public health and nutrition. Black et al., (2013) estimated that undernutrition in the aggregate including fetal growth restriction, stunting, wasting, and deficiencies of vitamin A and zinc along with sub optimum breastfeeding is a cause of 3·1 million child deaths annually or 45% of all child deaths in 2011. Sustainable Development Goals statistics and studies concentrates on water, sanitation and Hygiene without considering determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of pupils in Yatta Sub County, Machakos County.

2.15 Summary of the Literature Review

According to a new report launched by the United Nations (WESS, 2016), evidence is increasing that climate change is taking the largest toll on poor and vulnerable people, and these impacts are largely caused by inequalities that increase the risks from climate hazards. Food and nutritional security are the foundations of a decent life, a sound education and the achievement of the Sustainable Development Goals (UN, 2015).Water is a key element in the achievement of food and nutrition security. However water is scarce. Water scarcity already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water (UNDESA, 2013).

This uncertainty over the availability of groundwater resources and their replenishment rates pose a severe challenge to serve as a buffer to offset periods of surface water scarcity (Vander Gun, 2012). Drought is one of the most common causes of food shortages in the world. In 2011, recurrent drought caused crop failures and massive livestock losses in parts of Ethiopia, Somalia and Kenya. In 2012 there was a similar situation in the Sahel region of West Africa (WFP, 2012). Kenya’s land mass are prone to drought and its impacts are felt across the nation (Fitzgibbo, 2012). Kenya’s key economic sectors, such as Agriculture, Livestock, and Tourism, are all climate-sensitive. The economic, social and environmental impacts of drought are huge in Sub Saharan of Africa (SSA) and the national costs and losses incurred threaten to undermine the wider economic and development gains made in the last few decades in the region (Bekele et al., 2014).

Kenya is a Sub-Saharan country undergoing rapid urbanization resulting in changing lifestyles and dietary habits; the so-called nutrition transition (Steyn et al., 2012). Most chronic diseases in adulthood originate from dietary practices which are mainly formed during childhood (Hwenda, 2013).

Many of the schools supported through the school feeding program have considerable problems accessing clean water, adequate fuel supplies, and fruits and vegetables to supplement the basic school feeding program in targeted arid and Semi-Arid land areas (WFP, 2013). The vast majority of hungry people (827 million) live in developing countries, where 14.3 percent of the population is undernourished (FAO, 2013). One in four of the world's children is stunted.

In developing countries the proportion can rise to one in three (Public Health Nutrition, 2012). 66 million primary school-age children attend classes hungry across the developing world, with 23 million in Africa alone (WFP, 2012). All in all, there has been a marked reduction in malnutrition since 2008/9; Stunting has decreased from 35 percent to 26 percent, wasting from 7 percent to 4 percent, and underweight from 16 percent to 11 percent (KDHS, 2014). However, according to Chitima et al. (2017), Children living in rural areas in Kenya are particularly vulnerable to stunting, wasting and underweight. Higher levels of under-nutrition have been found especially in dry seasons compared to wet seasons, implying that nutritional intake is highly dependent on rainfall (Chitima et al., 2017) in Arid and Semi Arid regions of Kenya

2.16 Conceptual Framework

Causes of malnutrition and impaired learning ability of pupils are multisectoral, embracing food availability, health status and sanitation. Figure 1.1 demonstrates the effect of improved water supply on dietary intake, nutrition status and morbidity rates of the pupils in public mixed day primary schools, in Yatta Sub County. It explains the relationship between improved water supply, dietary intake, and pupils' nutritional status. Malnutrition impairs negatively to the ability of pupils at different levels and depths. There are immediate causes, underlying causes at the household level and basic causes at the society level.

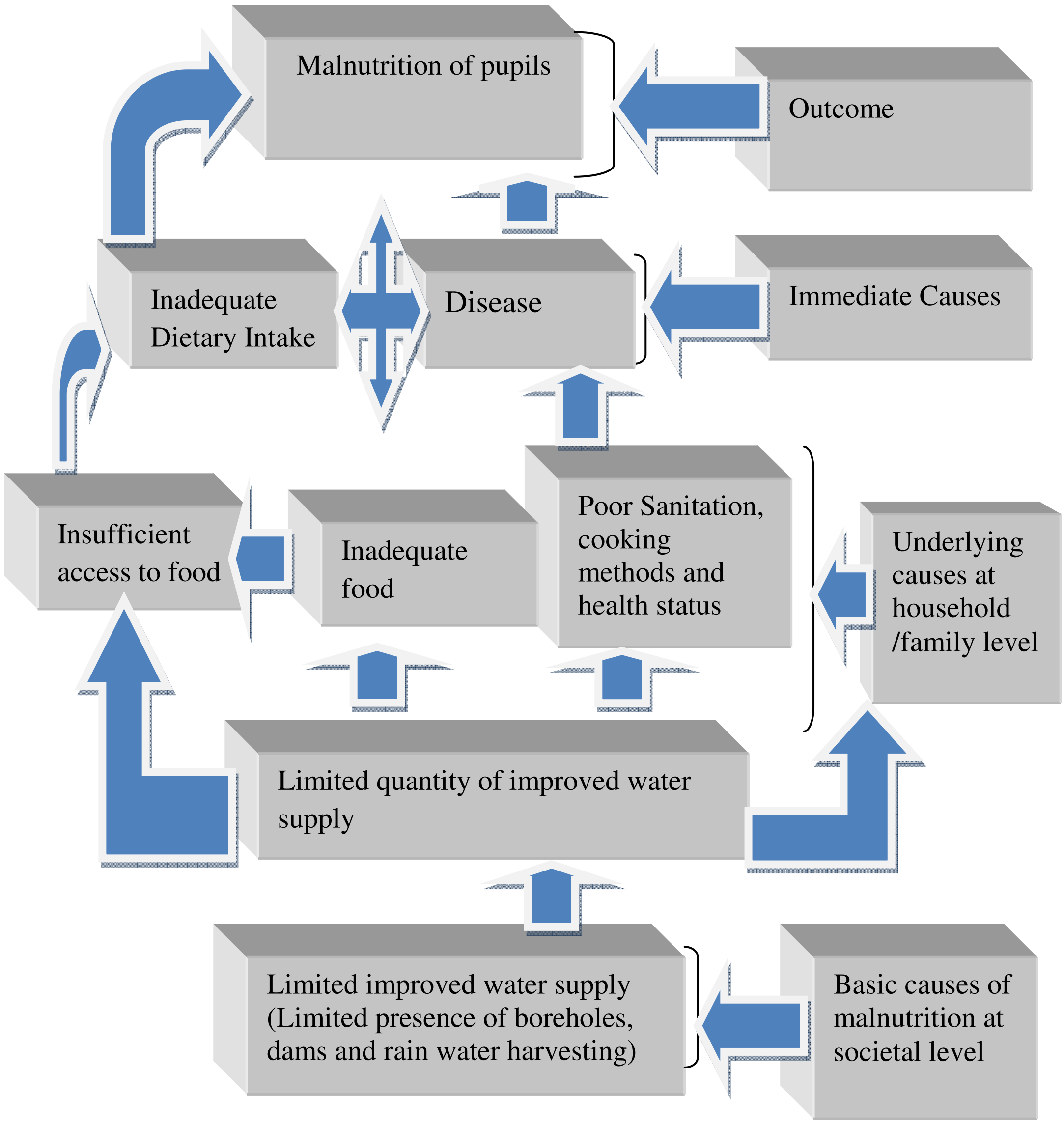

Figure 2.1: Effect of limited improved water supply on dietary practices and nutritional status of pupils in Yatta Sub County

Source: Adapted from UNICEF, 1990

Implications of malnutrition include weight loss and growth faltering. For instance, long-term malnutrition is associated with impaired mental development and more susceptibility to illness and diseases.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter presents the methodology of the study. It includes sections on: research design, variables, location of the study, study population, sampling procedures, research instruments, data collection, analysis and ethical consideration.

3.2 Study Design

The study was analytical and cross-sectional that employed both qualitative and quantitative methods. It was designed to assess the dietary intake, food consumption practices, nutritional status and morbidity status of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County, Machakos County concerning improved water supply. The design was developed for collection of both qualitative and quantitative data (Mugenda et al., 2003). The analytical design was meant to identify and quantify associations, test hypotheses, identify causes and determine whether an association existed between variables. It was specifically meant to establish the relationship between nutritional status, dietary intake, food consumption practices and morbidity rates between pupils with and without improved water supply.

Observations in one group (pupils with improved water supply) in the population were compared to another group (Pupils without improved water supply, also called 'reference group'). Observations were systematically made to determine how exposure and outcome were distributed in the populations. comparison of the observations was then made (Fig 3.1).

The study also had a laboratory analysis component. Determination of proximate composition of main foods consumed by pupils was carried out. This was purposely done to determine the nutritional value of food consumed by pupils with and without improved water supply. The dietary intake, food consumption practices, nutritional status and morbidity rates of pupils in the schools with improved water supply were compared to those in the schools without improved water supply.

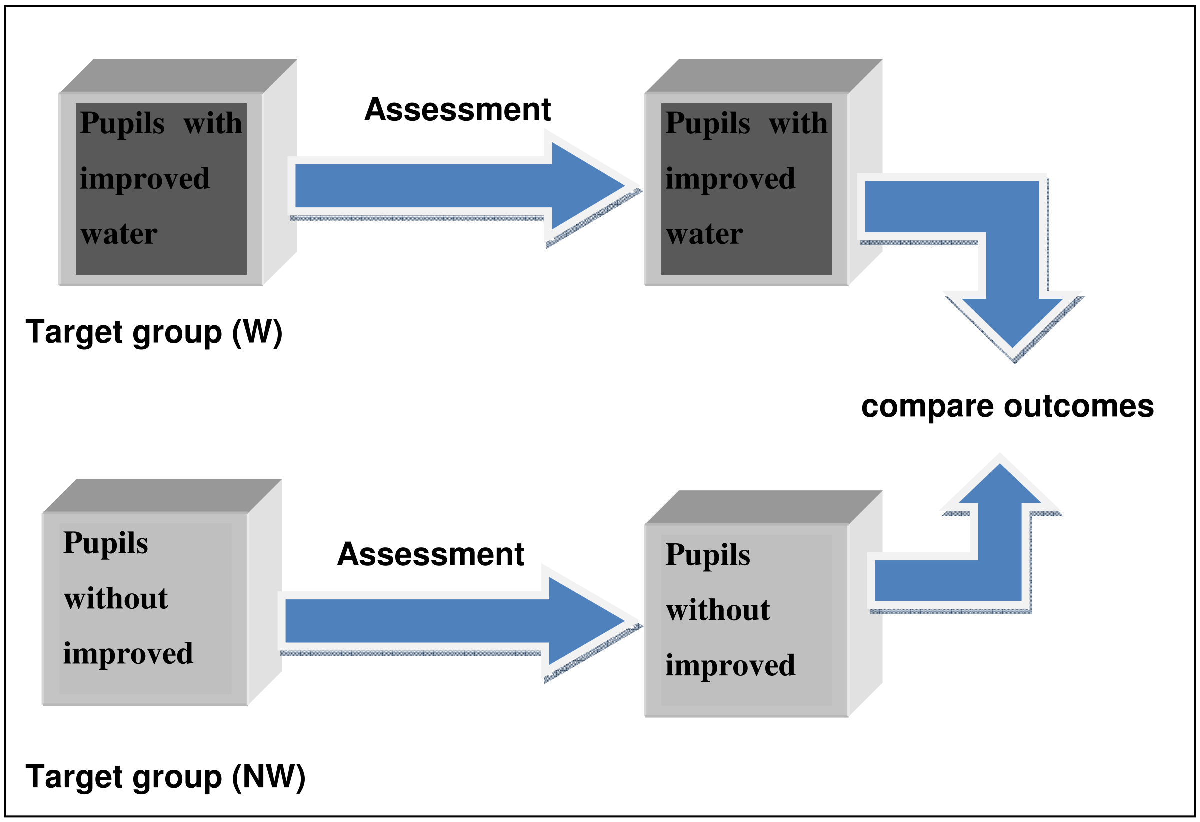

Figure 3.1: Graphic presentation of the study design

Schools with improved water supply such as boreholes, water harvesting tanks were identified. The study was carried out targeting pupils aged 6-13 years .The data collected was then used to determine the effect of improved water supply on dietary intake, nutritional status, food consumption practices and morbidity status of school going pupils in a semi-arid region, Yatta Sub County.

The study was extended to the households where dietary intake; food consumption practices, nutritional status and morbidity status of pupils in households that received water were compared to those that did not receive water. This was purposely to confirm the information that was collected from pupils and personnel in the schools. The study also involved laboratory analysis of food samples eaten by pupils to determine the proximate nutrient content. Chemical analysis Standard Procedures of AOAC were used as a confirmation of dietary intake of pupils.

3.3 Variables

The dependent variables in the study were dietary intake, nutritional status, food consumption practices and morbidity rates. The independent variables were demographic factors, socio-economic factors and improved water supply.

3.4 Study site

The study was conducted in Yatta Sub County which was purposely chosen based on the reviewed literature and given that it is an Arid and Semi Arid region where rainfall was inadequate. The temperatures range from $10^{o}C$ to $28^{o}C$. The altitude of Yatta ranges between 700-800 meters above sea level where evaporation exceeds rainfall (ASDP, 2016).The Sub County comprised of three divisions that were involved in the study, namely: Ikombe, Katangi and Yatta. The region is a semi-arid region that is about 50 km from Thika and 100km from Nairobi city. The study was carried out in public mixed day primary schools.

3.5 Target Population

The target population was public mixed day primary school pupils aged 6-13 years in Yatta Sub County, Machakos County Kenya.

3.6 Sampling and sample size

3.6.1 Sample size determination

In 2012 there were one hundred and twenty four (124) public primary schools with a total population of forty three thousands and thirty four (43,034) pupils in Yatta Sub County. Most of the schools had an average population of three hundred and fifty (350) pupils per school. There were twenty one thousand seven hundred and forty one (21,741) boys and twenty one thousand two hundred and ninety three (21293) girls. The ratio of boys to girls was therefore 1:1. The population was more than 10,000 pupils. This therefore led to adopting the Fisher et al., 1983, formula stated below to establish minimum sample size:

$N=Z^2pq/d^2$ where

z=the standard normal deviate at the required confidence level

p=the proportion in the target population estimated to have characteristics being measured.

q=1-p

d=the level of statistical significance.

However given that no estimate was available of the proportion on the target population assumed to have the characteristics of interest (pupils aged 6-13 years), then 50% was used as recommended (Fisher et al., 1983). The proportion of target population is 0.5., the z-statistic is 1.96 and accuracy is desired at 0.05 levels, then the sample size is:

N= (1.9622) (0.50) (0.50) / (0.05) =384, approximated to a population of 400 pupils.

(Fisher et al., 1983).

The target sample size comprised of 200 girls and 200 boys who added up to a population of 400 pupils aged 6-13 years (school going age) in Yatta Sub County, Machakos county.

3.6.2 Sampling procedure

3.6.2.1 Sampling of Schools

Public mixed day primary schools were purposely selected on the basis of having many pupils of both sexes. At the time of the study, there were 124 public primary schools. A total of six public schools from the Government day schools were purposely selected within the Sub County. Each school was stratified by gender. Two schools were selected from each Division where, one school must have had improved water supply (borehole, water tanks and so on) for more than six months while the other did not have improved water supply. The fifth and sixth schools (with highest pupils' population) one with and the other without improved water were purposely sampled from the Division that had the highest pupils' population (Yatta Division).

3.6.2.2 Sampling of Pupils

Approximately 66-68 (33-34 girls and boys depending on the school population) pupils were sampled from each school which added to the sample size of 400 hundred pupils. A simple random sampling was employed to select the target sample size of four hundred (400) pupils considering each gender stratum, within six public mixed day schools from three divisions of Yatta Sub County. In order to sample pupils, a list of pupils aged 6-13 years from each gender stratum was used to carry out simple random sampling in each school.

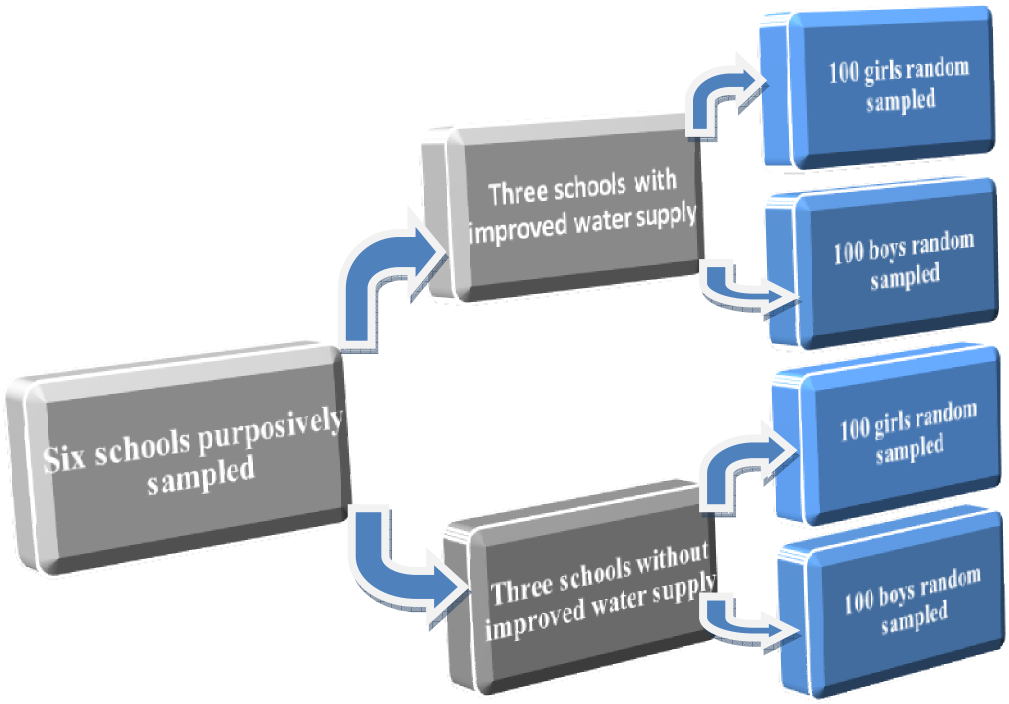

Figure 3.2: Graphic presentation of sampling procedure

Simple random sampling was computer generated using random number generator, targeting 33-34 per stratum and 66-68 per school depending on the school's population size. Simple random sampling gave each pupil within a large population an equal chance of being selected (Figure 3.2).

3.7 Data collection instruments

A semi structured questionnaire, Focus Group Discussions (FGDs) and Key Informants Interview (KII) were used to collect data on the effect of water supply on pupils' dietary intake, nutritional status, food consumption practices and morbidity rates.

3.7.1 Demographic and social economic characteristic information of pupils in primary schools

A questionnaire was used to collect data based on age, sex, religion, mother's education level, father's education level and parents' marital status with respect to improved water supply.

3.7.2 The 24-hour recall instrument

A questionnaire was used to determine the type and quantity of ingredients used and amount of food taken in the previous 24 hours by each pupil. Foodstuffs were measured using the commonly used household containers. These were spoons, cups, glasses, plates, jugs and flasks. Volumes of each were related to measuring cylinders, cups, and spoons to determine the volume of each food quantity. Liquid measuring cylinders of 5ml, 100ml and 1000ml were used. The 24-HR dietary recall was relied on to provide accurate estimates of energy intake at the population level. In the present study, dietary information was collected by the multiple pass 24-HR approach, which was relied on to provide accurate estimates of dietary intake in children (Burrows et al., 2010). The recalls were taken by the nutritionists research assistants who went through extensive training prior to data collection in order to minimize interviewer errors.

3.7.3 Food Frequency instrument

A questionnaire was used to establish the frequency of consumption of certain types of food (those of particular interest in the survey) that were consumed over a specified time-frame normally a week (Appendix ii). The foods were grouped into seven main food groups.

3.7.4 Focus Group Discussions (FGDs)

Focus Group Discussions (FGDs) were carried out to collect qualitative data. Two FGDs were conducted, one from schools with improved water supply and the other from schools without improved water supply. They comprised of eleven (11) PTA members (parents' representatives from each class , a head teacher, one teacher and one officer from Education Sub County office).

3.7.5 Key Informants Interview (KII)

This was conducted using eight Key Informants (two parents, two cooks, two teachers, and two head teachers) each one from the six schools with improved water supply (Katangi, Kithimani, Kitheuni) and without improved water supply (Kasaani, Mukalala, Nguumo).This was done to collect information on water availability, sanitation and hygiene. Kitchens, dining room and the environment, kitchen personnel, food storage, quality and quantity of food cooked, meals eaten by students while at school and when at home of other information stipulated in the check list. Key Informants Interview Guide (Appendix ii) was used.

3.7.6 Household Food Insecurity Access Scale (HFIAS) measurement tool

This was used for measurement of Household Food Access. Focus Group Discussion members who were familiar with the conditions and experiences of household food insecurity (access in the areas and not part of the survey sample) were gathered to collect data on pupils' food adequacy at household level. They were consulted as a group, so that any discrepancies in their suggestions could be clarified at the same time. However discussions were done with one respondent at a time. Focus Group Discussion Guide was used for collection of information (Appendix ii). Once all of the respondents had provided their input, the notes from all of these discussions were pooled and examined. Based on respondent feedback, particular phrases, definitions, words, or examples that were unclear were reworded accordingly, to retain the original meaning of the question while making the meaning clearer to respondents where necessary. The final product was an improved draft questionnaire ready to be pre-tested in the field.

3.7.7 Laboratory experiment

Determination of proximate composition of main foods consumed by pupils was carried out. This was purposely carried out to ascertain the nutritional value of food consumed by the pupils.

Chemical Analyses Standard procedures of AOAC were used to determine the moisture content, crude fat, crude protein (N x 6.25), ash and Nitrogen free extract (NFE) (AOAC, 1990). Data was reported as the mean ± SD for three determinations3.7.8 Anthropometric measurements tool.

3.7.8 Anthropometric measurement

A stadiometer (Stadiometer- PAT NO.4, 694, 581 DES.PAT.PEND), calibrated to the nearest 1cm, was used to measure height. A bathroom scale with an accuracy of 1g was used to measure weight (Elekta mechanical personal scale, model:EWS-878, calibrated to the nearest 1g). The measurements were used to determine the Body Mass Index (BMI) of pupils, with the help of BMI Calculator for Child and Teen (5-19 years) (WHO, 2007). Inter-observer measurement error in the anthropometric assessment was minimized by extensive training and follow up to maintain quality of measurement of all nutritionists research assistants.

3.7.9 Observation Check list tool

An adapted and validated healthful school environment evaluation checklist (Appendix II) was used to record information and score each school on the status of their environment. The checklist was adapted from "School Health Practice" by Anderson and Creswel (1980) with the incorporation of key elements of Kenyan` National Policy Guidelines on schools' sanitation.

3.8 Pre-testing

A pre-test to assess the validity and reliability of data collection tools was carried out. sixty (60) sampled pupils aged 6 to13 years in two public mixed day primary schools (one with improved water supply and the other without) were used to test the tools.

The schools were Ndalani primary (with improved water supply) and Sofia Primary (without improved water supply). Thirty Pupils (15 girls and 15 boys) were selected from a school without improved water supply and other thirty (15 girls and 15 boys) from school with improved water supply. The pupils on which the instruments were pre-tested were not part of the selected sample of the study. The research tools were revised and standardized as per the pre-test results. The purpose of pre-testing the instruments was to ensure that items in the instruments are stated clearly and have the same meaning to all respondents. Items identified as sensitive, confusing or biased in anyway were modified.

3.9 Data Collection

Permission was sought from the Sub County Education Office to conduct the study after which the head teachers of the schools requested the consent of the parents / caretakers of the pupils. The selected six schools and homes of sampled pupils were visited by the research assistants to collect data by administering the questionnaire. Each questionnaire had an informed consent form which the respondents were required to sign after understanding the purpose of the study. Data collection was carried out on weekdays starting from 28th February 2012 to 2nd April 2012 and at convenient times, to avoid interfering with schools' and parents' programmes (Data collection schedule on Appendix xii). Special arrangements were made to interview those parents who were not available on weekdays. A pre-tested structured questionnaire was used to collect information on socio-demographic characteristics, dietary intake, food consumption practices, nutritional status and morbidity rates of pupils.

3.9.1 Data collection on Demographic and Social Economic characteristic of pupils in primary schools

Data on age, sex, religion, mother's education level, father's education level and parents' marital status and household size with respect to improved water supply was collected.

3.9.2 Data collection on dietary intake of pupils aged 6-13 years in mixed day public primary schools

The 24-hour dietary recall: Pupils were interviewed to state all foods they had consumed in the previous 24 hours. To determine the actual amount of food taken, a calibration table (Appendix ii) was developed. All consumed foodstuffs were measured using the commonly used household containers both at pupils' schools and homes. These were spoons, cups, glasses, plates, jugs and flasks. Volumes of each were related to measuring cylinders, cups, and spoons to determine the volume of each food quantity. Liquid measuring cylinders of 5ml, 100ml and 1000ml were used to measure foods. Households were further visited to confirm from parents what the pupils had consumed.

3.9.3 Food consumption Practices

3.9.3.1 Food consumption frequency

Frequency of food consumption was established. According to Nutrition for Developing Countries (King et al., 1992), regularity of consumption of food depends on the number of times the food is consumed per week. Consumption rates of 4-7 times per week or higher was classified regular and 0-3 times per week was classified irregular. Parents and caretakers were visited to confirm food consumption frequency of the pupils.

3.9.4 Household Food Insecurity Access Scale (HFIAS) measurement

Focus Group Discussion (FGD) members were asked to state the status of livelihood and food security of their household during pre- and post- improved water supply (Water harvesting tanks, boreholes). They were further asked if they met all food requirements all round the year, for their household members from their own production and if not, to state the principal reasons for lack of sufficient dietary intake at household level and viable income from non-farm activities. In addition they were asked to state how they coped with the food shortage challenges and the effect of improved water supply. Household members were also asked to state food insecurity coping mechanisms they had put in place to sustain dietary intake and nutritional status of pupils aged 6-13 years. Coping mechanisms were classified as critical and non critical.

Household food access was determined where households were classified as having: an adequate food access, a mild food access deficit (less severe), a moderate food access deficit (moderate severe) and a severe food access deficit (severe) (FANTA, 2007). Accessibility of food by pupils in schools with improved water supply and those without improved water supply was, also, discussed. Qualitative data was collected from both pupils in schools with improved water supply and those without improved water supply.

3.9.5 Laboratory experiment Determination of proximate composition of main foods consumed by pupils

Chemical Analyses Standard procedures of AOAC were used to determine the moisture content, crude fat, crude protein (N x 6.25), ash and Nitrogen free extract (NFE) (AOAC,1990) in food samples pupils fed on. The parameters established were:

(i) Moisture content (AOAC, 2003).
(ii) Crude ash (AOAC, 1965).
(iii) Crude fat content (Soxhlet, 1978).
(iv) Fibre content (AOAC, 2003).
(v) Protein content (Kjeldhal, 1883).
(vi) Carbohydrates (AOAC, 2003).

3.9.5.1 Determination of moisture content in various food samples

Moisture content was determined by oven drying method (AOAC, 1995, method 925.10-32.1.03). A clean, dried empty crucible was weight (W0) 1.5 g of well-mixed samples were accurately weighed in clean, dried crucible (W1).

The crucible was allowed in an oven at 105 ^{o}C for 3 hours until a constant weight was obtained. Then the crucible with its content was placed in the desiccators for 30 minutes to cool. After cooling, it was weighed again (W2). The percent moisture was calculated by following formula:

Moisture content percentage is equal to: (W1-W2/W1-Wo) X 100

Where, W_0 is the weight of the empty dish.

W1 is the weight of dish and sample.

W2 is the weight of dry dish and sample

(Shreve et al., 2006).

3.9.5.2 Determination of crude ash in food samples

Determination of crude ash in food samples was carried out using muffle furn (AOAC, 2003 method 923.03). The food samples were weighed before and after ashing to determine the concentration of ash present. The ash content is expressed on a dry basis:

$\%$ of ash = W_{ash} / W_{dry} x100

Where $W_{\mathbf{ash}}$ is the weight of the ashed sample, and $W_{\mathbf{dry}}$ is the original masses of the dried samples. Typically, samples are held 550°C for one hour.

During determination of ash, clean empty crucible was placed in a muffle furnace at 550°C for an hour, cooled in desiccators and weight of empty crucible was noted (W_0). One gram of each of 1 sample was taken in crucible (W1). The sample was ignited over a burner with the help of blow pipe, until it was charred. Then the crucible was placed in muffle furnace at 550°C for 2 hours. The appearances of gray white ash indicated complete oxidation of all organic matter in the sample. After ashing the furnace was switched off. The crucible was then cooled and weighed (W2).

Percent ash was calculated as follows:

$$\text{Ash \% weight} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

Percentage of ash was equal to W2-W0/W1-W0, times one hundred where: W0 was weight of an empty crucible.W1 was weight of crucible plus sample. Therefore W2 was weight of a crucible and ash.

3.9.5.3 Determination of fat content in food samples

Fat content was determined using a Soxhlet extractor (AOAC, 2003 method 945.38F, 920.39C) during the experiment. Food samples were weighed on an analytical balance (SHIMADZU AEG 220.00) and mixed with anhydrous sodium sulfate using a ratio 4:1.3. Hexane measuring 150 ml was poured into 250 mls round-bottomed flask with boiling chips. Soxhlet apparatus was set for the extraction. After about an hour of extraction, the round-bottomed flask was heated in the water bath of the concentrator apparatus. The solvent was removed and the excess water outside the flask was dried. The extracted fat was weight and the fat content of the sample was determined. Fat content was measured by weight of fat removed.

Determination of fat content in food samples was carried out as follows:

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

3.9.5.4 Determination of Fiber content

Dietary fibre / crude fibre was determined (AOAC, International, 2003, method 985.79, 991.43). Samples were gelatinized in the presence of heat stable alpha amylase, and then enzymatically digested with protease and amyloglucosidase to remove digestible protein and starch. Four volumes of ethanol were added to precipitate soluble dietary fibre. Total residue was filtered off and washed with ethanol and acetone.

The residue was weighed after drying. The remaining material was analyzed for protein and ash content, respectively. Subtracting the amounts measured for protein, ash and a blank control from the dry weight of the filtered residue yielded a value for total crude fibre content.

3.9.5.5 Determination of Protein

Protein was determined using the Kjeldahl method (AOC, 1995, method 20.8732.1.22). The digestion method in analytical chemistry is a method for the quantitative determination of nitrogen in chemical substances developed by Johan Kjeldahl in 1883. Heating of 1g of food sample was done with sulphuric acid. This decomposed the organic substance by oxidation to liberate the reduced nitrogen as ammonium sulphate . Potassium sulphate was then added to increase the boiling point of the medium (from 337 °C to 373 °C). Chemical decomposition of the sample was complete when the initially very dark-coloured medium became clear and colourless.

The solution was then distilled with a small quantity of sodium hydroxide, which converted the ammonium salt to ammonia. The amount of ammonia present, and thus the amount of nitrogen present in the sample, was determined by back titration. The end of the condenser was dipped into a solution of boric acid. The ammonia reacted with the acid and the remainder of the acid was then titrated with a sodium carbonate solution by way of a methyl orange pH indicator.

Degradation: Sample + $H_2SO_4 \rightarrow (NH_4)_2SO_4(aq) + CO_2(g) + SO_2(g) + H_2O(g)$

Liberation of ammonia: $(NH_4)_2SO_4(aq) + 2NaOH \rightarrow Na_2SO_4(aq) + 2H_2O(l) + 2NH_3(g)$

Capture of ammonia: $B(OH)_3 + H_2O + NH_3 \rightarrow NH_4^+ + B(OH)_4^-$

Back-titration: $B(OH)_3 + H_2O + Na_2CO_3 \rightarrow NaHCO_3(aq) + NaB(OH)_4(aq) + CO_2(g) + H_2O$ (AOAC + International).

$$\text{Protein (\%)} = \frac{A\text{-}B \times N \times 1.4007 \times 6.25}{W}$$

Where A=Volume (ml) of 0.2N HCl used sample titration.

B= Volume (ml) of 0.2 N HCl used in blank titration

N= Normality of HCl

W =Weight (g) of sample

1.4007 = atomic weight of nitrogen

6.25 = the protein-nitogen conversion factor for the protein source and its by product.

3.9.5.6 Determination of carbohydrates

The proximate analysis (carbohydrates, fats, proteins, moisture and ash) of all plant samples were determined by using AOAC methods. Carbohydrate was determined by difference method [100 - (Protein +Fats +moisture +ash)]. Under this approach, the other constituents in the food (protein, fat, water, alcohol, ash) were determined individually, summed and subtracted from the total weight of the food. This is referred to as total carbohydrate by difference. It was calculated by the following formula: 100 – (Weight in grams [protein + fat + water + ash + alcohol] in 100 g of food).

It should be clear that carbohydrate estimated in this fashion includes fibre, as well as some components that are not strictly speaking carbohydrates. Available carbohydrate represents that fraction of carbohydrate that can be digested by human enzymes, is absorbed and enters into intermediary metabolism. (It does not include dietary fibre, which can be a source of energy only after fermentation - see the following subsections). Available carbohydrate can be arrived at by estimated difference, or analyzed directly (Beach et al., 1986). Available carbohydrate was arrived at by estimated by difference as follows: 100 - (weight in grams [protein + fat + water + ash + alcohol + dietary fibre] in 100 g of food).

Carbohydrate was calculated by difference on both raw and cooked pupils' food samples. **(AOAC, 2003).**

3.9.6 Data collection on nutritional status of pupils aged 6-13 years in Yatta Sub County Anthropometric measurement

All Pupils were measured without shoes and in light clothing. Anthropometric measurements taken were weighed, to the nearest 0.1kg and height, to the nearest 0.1cm. A150kg stadiometer was used to measure height; the height of each student was measured twice, and if the difference between the measurements was more, a third measurement was taken. The weight of each pupil was determined using a bathroom scale (Elekta mechanical personal scale, model: EWS-878) calibrated to the nearest 1g to measure each pupil's weight and a height board (Stadiometer- PAT NO.4, 694,581 DES.PAT.PEND) calibrated to the nearest 1cm was used to measure each pupil's height. The measurements were taken twice, with a third measurement taken if the difference between the measurements was 300 g or more.

Body Mass Index (BMI) for age was therefore determined by each pupil's weight being divided by the square of his/her height. The indices were then compared to the World Health Organization (WHO, 2007) reference norms indicated below.

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

Interpretation of cut-offs of BMI-for-age (5-19 years):

Overweight: >+1SD (equivalent to BMI 25 kg/m^2 at 19 years) Obesity: >+2SD (equivalent to BMI 30 kg/m^2 at 19 years) Thinness: <-2SD Severe thinness: <-3SD (WHO, 2007).

The WHO growth reference data for 5-19 years was employed to compute standard deviation scores for BMI-for age used in assessing thinness of pupils.

3.9.7 Observation Check list data collection

Observation Check list guide (Appendix ii) was used to collect information on construction materials, source of water, general sanitation and hygiene of the kitchens, dining room and the environment, ventilation, drainage, kitchen personnel, food storage, quality and quantity of food cooked, meals eaten by students Of other parameters. The availability of the various components of school environment such as the school buildings quality and evidence of maintenance. Also if it contained sections on infrastructural facilities like: refuse and sewage disposal materials, water supply, safety measures facilities. Parameters for assessing the presence of other materials for healthy living were, for example like the availability of wash hand basins, drinking fountains. Other parameters were soap for hand washing and the presence or otherwise of visible biological and physical health hazards. These were also included in the checklist. Scores were allocated to each item based on its importance. For example, regarding schools` water sources, a score of four, three, two, and one was allocated to sources from piped water, bore-hole, well and dams respectively. For accessibility of the water sources, a score of three, two and one were allocated if a water source was located within the school premises, not more than 200 metres from the school and if more than 200metre from the school premises respectively.

The checklist was administered and a `face to face` interview conducted separately with key informants. The head teachers provided the school administrative data and helped in making further clarification(s) on any observation where necessary. The toilet to pupil ratio (Recommended standard by the Ministry of Education is 25:1 (girls) and 30:1 (boys) in each school was obtained by dividing the pupils' population by the total number of toilets.

The space of a classroom floor was judged standard if the space containing 36 pupils arranged in six rows and columns was not less than 19.4 meters square (Government of Kenya, National School Health Policy, 2009).

While ventilation was judged adequate if the windows and doors were positioned in a way that allowed cross ventilation and their combined areas accounted for at least a quarter of the floor space (Government of Kenya. National School Health Policy, 2009).

3.9.8 Morbidity status Pupils aged 6-13 years Yatta Sub County

Pupils were asked to state whether they had been ill in the past one month and the type of illness they suffered from. Observation check list (Appendix ii) was used to capture data on the status of water and sanitation. Information on the main source of drinking-water and if the water was treated in any way before it was used was also collected. The morbidity rates of pupils with improved water supply and those without improved water supply was captured as well.

3.10 Data Management and Analysis

Data was cleaned, coded, sorted, entered into the computer and processed using Statistical Package for Social Sciences (SPSS) software version 20.0. Quantitative data was summarized using descriptive statistics, mean frequencies and percentages. Data analysis was done using Statistical Package for Social Science (SPSS) in order to determine the contribution of improved water supply on dietary practices, nutritional status and morbidity rates of pupils. Therein, the researcher employed a two sample t-test statistical approach in comparing the differences between the underlying study subjects' with regard to presence or absence of improved water supply.

The 24-hour dietary recall data was analyzed using Nutri-survey software to establish the dietary habits and nutritional status of pupils was used for analysis. Nutrient Intakes by WHO/FAO (2003, 2004) served as the reference. Food frequency was analyzed based on the number of times the food was consumed. The consumption of foods for more than four times a week was considered regular.

Consumption of foods for 0-3 times a week was considered irregular (King et al., 1992). Results from schools with improved water supply were compared to the schools without improved water supply.

Anthropometrical data measurements were used to determine height/age, weight/age and BMI/age indices for pupils. AnthroPlus-2007 software (WHO AnthroPlus for personal computers: software for assessing the growth of world's children and adolescents, Geneva, Switzerland) was used in the assessment of nutritional status. All data were entered in duplicate and validated using Epi-Info soft ware, (Centers for Disease Control and Prevention. Atlanta, USA) (WHO, 2007).

The WHO/Epi info (Version 3.4.1) was used to determine, the standard deviation scores for HAZ and WAZ from the weight and height measurements, stunted and underweight pupils. The WHO growth reference data for 5-19 years was employed to compute standard deviation scores for BMI-for age used in assessing thinness of pupils. The Body Mass Index (BMI) was used to determine the nutritional status of pupils. The Body Mass Index (BMI) is the best proxy for body fat percentage of ratios of weight and height (Keys et al., 1972). Results of Pupils with improved water supply was compared to those without improved water supply with respect to BMI.

The dependent variables height/age, weight/age and BMI/age were analyzed as categorical. The WHO BMI 5–19 years chart and height-for-age charts were used (WHO growth reference 2007). Children with height <–2 SD in height-for-age chart were considered stunted according to the WHO growth reference 2007 (WHO, 2007). Also, BMI <–2 SD was considered thin, and > +2 SD was considered overweight or obese. Statistical associations were estimated in relation to these indices.

The chi-squared test was used to compare categorical variables of the groups. This test, with, was applied to dichotomous variables, considering a statistical significance of $P < 0.05$. The indices were compared to the WHO reference norms (WHO, 2007). Results from schools with improved water supply was compared to the schools without improved water supply.

Regression analysis model was applied to explore the relationship between the variables. In the latter, a simple regression was conducted to assess how different independent variables (dietary intake and morbidity rate) predicted the nutritional status (dependent variable) of pupils.

Pearson product-moment correlation coefficient (sometimes referred to as the PPMCC or PCC, or Pearson's *r*) a measure of the linear correlation (dependence) between two variables *X* and *Y*, giving a value between +1 and −1 inclusive, where 1 is total positive correlation, 0 is no correlation, and −1 is negative correlation (Stigle et al., 1989) was used in the study as a measure of the degree of linear dependence between variables. It was used to determine the presence of relationship between dietary and the nutritional status of the pupils for non-categorical variables. The P- value of < 0.05 was used as the criterion for statistical significance.

Hypothesis tests on the regression coefficients obtained in simple linear regression was done. A statistic based on the distribution was used to test the two-sided hypothesis. Chi-square was used to determine the association between variables to test whether there were significant differences between two means derived from independent variables at significant level of 0.05. Quantitative data was presented using tables, graphs and charts.

Laboratory experiment: Chemical Analyses Standard procedures of AOAC were used to determine the moisture content, crude fat, crude protein (N x 6.25), ash and Nitrogen Free Extract (NFE) (AOC, 1990).Various food samples consumed by the pupils at home and in schools were collected and subjected to various tests, for establishment of sample proximate composition. One hundred grams of each food sample was collected and packed in plastic bags and carried in cool boxes to the laboratories.

The parameters established were:

(i) Moisture content (AOAC, 2003).
(ii) Crude ash (AOAC,1965).
(iii) Crude fat content (Soxhlet, 1978).
(iv) Fibre content (AOAC, 2003).
(v) Protein content (Kjeldhal, 1883).
(vi) Carbohydrates (AOAC, 2003).

Results from schools with improved water supply were compared to the schools without improved water supply.

Observation Check list data analysis using the Statistical Programme for Social Science (SPSS) software version 12 was carried out. The results obtained from the public schools with and without improved water supply were compared using the Mann-Whitney U Test and the Pearson's chi-squared 2 tests as applicable. The Mann-Whitney U is a non-parametric test used to assess for significant differences in a scale or ordinal dependent variable by a single dichotomous independent variable (Mann & Whitney, 1947). P values less than 0.05 were accepted as statistically significant. Analysis of qualitative data: Qualitative data was collected from Focus Group Discussions (FGDs) and Key Informants Interviews. It consisted of data on dietary intake, nutritional status and morbidity rates of the pupils.

Although qualitative data analysis is inductive and focuses on meaning, approaches in analyzing data, are diverse with different purposes and ontological (concerned with the nature of being) and epistemological (knowledge and understanding) underpinnings (Morse et al., 2002). Qualitative data analysis consisted of examining, categorizing, tabulating and recombining evidence obtained from the research. All these culminated to organization and interpretation of information to discover any important underlying patterns and trends. However each qualitative data was analyzed using a different method of analysis. Phenomenological method (a study that attempts to understand people's perceptions, perspectives and understandings of a particular situation) and Grounded method (A way of thinking about and conceptualizing data) were used.

3.11 Ethical consideration

Permission to carry out this study was sought from the relevant authorities. Consent for the study was obtained from the Ministry Of Science and Technology, Department of National Council for Science and Technology (Appendix 19). Approval was also obtained from the County Commissioner and the Sub County Education Office. Permission was further obtained from Head teachers, parents and pupils to participate in the study. Respondents were assured of the confidentiality of collected information. Assent was obtained from the pupils (Appendix 2).The required data was collected and used for the purpose of the study. Respondents unwilling to participate were exempted. Anonymity, confidentiality and privacy of the study participants were safeguarded.

CHAPTER FOUR

RESULTS

This chapter discussed findings based on the objectives of the study. The objectives were categorized into broad themes which relate to pertinent issues on the effects of improved water supply on Demographic and social economic characteristic, dietary intake, food consumption practices, nutritional status and morbidity rates of pupils aged 6-13 years in public mixed day primary schools in Yatta Sub County Kenya.

4.1 Demographic characteristic of pupils in public day primary schools in Yatta Sub County, Machakos County, Kenya

According to the findings, out of the sample of four hundred (400) pupils, 50.0 % were females while 50.0 % were male pupils. Two hundred of the pupils were selected from schools with improved water supply (W) and other two hundred were in schools without improved water supply (NW).The minimum number of household size Of households with pupils with and without improved water supply was 2.6 and 3.0 respectively. The maximum household size number for pupils with improved water supply was 4 and without improved water supply was 4.6. There was no significant difference (P = 0.073) between pupils with improved water supply and without improved water supply with respect to household size (Table 4.1). On average, most of the respondents were Protestants (55.3%). Of the same pupils, there were 54.5% who had improved water supply while 56.0% had no improved water supply. Catholics formed the second group (40.3%) who of pupils with and without improved water supply there were 40.5% and 40.0% respectively.

Table 4.1: Demographic characteristic of pupils in public day primary schools by Division in Yatta Sub County

Characteristics	variables	W N=200 N(%)	NW N=200 N(%)	P-Value
Each school sample size (%)	Katangi	66(33%)	0(0%)	0.000
	Kisaan	0(0%)	66(33%)	
	Kithimani HGM	68(34%)	0(0%)	
	Kitheuni	66(33%)	0(0%)	
	Mukalala	0(0%)	68(34%)	
	Nguumo	0(0%)	66(33%)	0.000
Household size	Min	2.6	3	0.067
	Mean	2 (4%)	8(3.8%)	0.054
	Max	8 (4%)	(4.6%)	0.073
Sex of pupils	Female	100(50%)	100(50%)	1.000
	Male	100(50%)	100(50%)	1.000
Religion of pupils	Protestant	109(54.5%)	112(56%)	0.763
	Catholic	81(40.5%)	80(40%)	0.919
	Islam	7(3.5%)	4(2%)	0.359
	Non respondents	3(1.5%)	4(2%)	0.703

W-With improved water supply NW-No improved water supply

On average, there were 2.8% Muslims, with 3.5% pupils with improved water supply and 2.0% without improved water supply. There was no significant difference ($P > 0.359$) between pupils with improved water supply and those without improved water supply with respect to religion (Table 4.1).

4.1.2 Social economic characteristic of parents and caretakers of pupils in Yatta Sub County

4.1.2.1 Education level of parents/guardian of pupils in Yatta Sub County

The education level of pupils' parents/guardians is presented in Table 4.2 below. On average most pupils (79.0%) their mothers had primary level education. Of the pupils with and without improved water supply, there were 78.5% and 79.5% respectively, whose mothers had primary school education. On average 12.0% of pupils their mothers had secondary school education. Of the pupils with and without improved water supply, 13.5% and 11% respectively, their mothers had secondary school education. Of the pupils with and without improved water supply 4.0% and 1.0% respectively, their mothers did not disclose their education level.

There were pupils (3.8%) whose mothers had no formal education. Of the pupils with improved water supply, 3.5% and 4.0% respectively, their mothers had no formal education. There was no significant difference (P = 0.792) between pupils with improved water supply and those who did not have with respect to the education level of their parents.

Table 4.2: Education level of Parents/guardians of pupils in Yatta Sub County

Characteristics	Variables	W N=200 N(%)	NW N=200 N(%)	P-value
Mother's education level	Primary	157(78.5%)	159(79.5%)	0.806
	Secondary	27(13.5%)	22(11.0%)	0.445
	No formal education	7(3.5%)	8(4.0%)	0.792
	Non respondents	9(4.5%)	11(5.5%)	0.646
Fathers' education level	Primary	156(78%)	144(72%)	0.165
	Secondary	31(15.5%)	37(18.5%)	0.424
	No formal education	5(2.5%)	7(3.5%)	0.558
	Non respondents	8(4.0%)	12(5.0%)	0.358

W-With improved water supply NW-No improved water supply

Of pupils with and without improved water supply,78.0% and 72% respectively, their fathers had primary education. Of those who had improved water supply, 15.5% of them their fathers had secondary education while those without improved water supply 18.5% of them their fathers had the same education level. Of pupils with and without improved water supply, 2.5% and 3.5% respectively, their fathers had no formal education. Of pupils with and without improved waters supply, 4.0% and 5.0% respectively, their fathers were nonrespondents. There was no significant difference (P = 0.358) between pupils who had improved water supply and those who did not have with respect to their fathers' education level (Table 4.2).

4.1.2.2: Marital status of parents of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Of children with improved waters supply, 72.5% of them, their mothers were married compared to those without improved water supply where 71.5 % of them their mothers were married. Of pupils with and without improved water supply, 14.5% and 16.0% respectively, their mothers were single. Of pupils with and without improved water supply 13.0% and 11.0% respectively, their mothers were widowed. Of pupils with and without improved water supply, 0.0% and 1.5% respectively, were non respondents. According to the study therefore, there was no significant difference (P > 0.05) between pupils who had improved water supply and those who did not with respect to their mothers' marital status (Table 4.3).

Table 4.3: Marital status of parents of pupils in Yatta Sub County

	Characteristics	**W N=200**	**NW N=200**	**P-value**
Fathers	Married	145(72.5%)	143(71.5%)	0.824
	Single parent	29(14.5%)	32(16%)	0.676
	Widowed	26(13.0%)	22(11%)	0.538
	Non respondents	0(0.0%)	3(1.5%)	0.081
Mothers	Married	145(72.5%)	143(71.5%)	0.824
	Single parent	23(11.5%)	26(13%)	0.647
	Non respondents	32(16,0%)	31(15.5%)	0.891

W-With improved water supply NW-No improved water supply

According to the study findings, of pupils with and without improved water supply there were 72.5% and 71.5% respectively, whose fathers were married. Of pupils with and without improved water supply, 11.5% and 13.0% respectively, their fathers were single. Of the non-respondents (15.8.0%) there were 16.0% and 15.5% respectively, with and without improved water supply . There was no significant difference (P = 0.891) between pupils with and without improved water supply with respect to their parents' marital status.

4.1.2.3 Occupation status of parents /guardians of pupils in Yatta Sub County

The highest population of pupils (62.5%) their male parents/guardians were casual laborers compared to their mothers (24.0%). Highest pupils' population (37.3%) their mothers were housewives who depended on their husbands for financial support. Of pupils with and without improved water supply, 63.0% and 62.0% respectively, their male parents/guardians were casual labourers. Most pupils (37.5%) their mothers were housewives who depended on their husbands and who were mainly engaged as casual labourers. Of pupils with and without improved water supply, 38 % and 37.5% respectively, their mothers were housewives. However, some pupils (24.0%) their mothers worked as casual laborers. There was a number of pupils (18.8%) whose mothers were engaged in small nonsustainable businesses. Of pupils with and without improved water supply, 18.5% and 19.0% respectively, their mothers were engaged in small businesses.

Table 4.4: Occupation status of parents /guardians of pupils in Yatta Sub County

Characteristics	Occupation	W N=200 N (%)	NW N=200 N (%)	P-value
Mother's occupation	**Cobbler**	0(0%)	1(0.5%)	0.316
	Businesswoman	37(18.5%)	38(19.0%)	0.898
	Casual laborer	47(23.5%)	49(24.5%)	0.815
	Waiter	3(1.5%)	4(2%)	0.703
	Farmer	17(8.5%)	18(9%)	0.860
	Housewife	76(38%)	75(37.5%)	0.918
	Hair dresser	4(2%)	6(3%)	0.522
	Non respondents	16(9%)	9(4.5%)	0.147
Fathers occupation	**Businessman**	35(17.5%)	36(18%)	0.896
	Casual laborer	126(63%)	124(62%)	0.836
	Driver	4(2%)	3(1.5%)	0.703
	Cook	4(2%)	4(2%)	1.000
	Farmer	9(4.5%)	10(5%)	0.814
	Mechanic	1(0.5%)	2(1%)	0.856
	Tailor	1(2%)	2(1%)	0.856
	Carpenter	1(2%)	2(1%)	0.856
	Watchman	6(3%)	7(3.5%)	0.778
	Non respondents	13(6.5%)	10(5%)	0.519

W-With improved water supply NW-No improved water supply

None respondents were 16.0% pupils with improved water supply and 15.5% of pupils without improved water supply, with respect to their mothers. Therefore was no significant difference ($P > 0.05$) between pupils who had improved water supply and those who did not have with respect to their parents' occupation (Table 4.4).

4.2 Effect of improved water supply on dietary intake of school pupils in Yatta Sub County

4.2.1 Types of food and number of meals consumed by pupils with and without improved water supply per day

Foods consumed by pupils with and without improved water supply were determined and presented as shown in Table 4.5. According to the findings, both pupils with and without water improved water supply, consumed maize and beans as their main staple food. Majority (91.0%) of the pupils with and without improved water supply had three meals per day. However, of pupils with and without improved water supply, 3.0% and 6.0% respectively had no lunch. In addition of pupils with and without improved water supply, 25.0% and 29.0% respectively had no snacks (Table 4.5).

Of pupils with and without improved water supply, 41.0% and 40.0% respectively took milk tea for breakfast. Slightly more pupils with improved water supply took tea with milk for breakfast compared to those without improved water supply. Of pupils with and without improved water supply, 3.0% and 4.0% had black tea for breakfast. Further, of pupils with and without improved water supply 3.0% and 5.0% respectively had porridge for breakfast. In addition, Of pupils with and without improved water supply, 2.0% and 1.0% had milk for breakfast. 42.0% pupils with improved water supply had bread for breakfast while 40.0% pupils without improved water supply had bread for the same meal. Of pupils with and without improved water supply, 3.0% and 2.0% respectively took Ugali for breakfast. Sukuma wiki was also consumed. Of pupils with and without improved water supply, 2.0% and 3.0% respectively took sukuma wiki for breakfast. Lastly of pupils with and without improved water supply, 4.0% and 5.0% respectively, took maize and beans (*Isyo)* for breakfast. There was no significant difference ($P > 0.05$) between pupils with and without improved water supply with respect to breakfast consumption (Table 4.5).

Consumption of snacks by pupils with and without improved water supply was determined. According to the findings, Of pupils with and without improved water supply, 10.0% and 12.0% respectively consumed Sugarcane as their snack. Of pupils with and without improved water supply, 4.0% and 2.0% respectively took tea with milk as snacks. Of pupils with and without improved water supply 30.0% and 20.0% took porridge as a snack. More pupils of pupils with improved water supply took porridge than pupils without improved water supply. There was a significant difference between pupils with improved water and those without improved water supply with respect to consumption of porridge as a snack. Of pupils with and without improved water supply, 12.0% and 15.0% respectively took ripe bananas as a snack. Further, of pupils with and without improved water supply, 15.0% and 17.0% respectively took mangoes as a snack. Of pupils with and without improved water supply 4.0% and 5.0% respectively took bread as a snack. There were pupils who never took any snacks. Of pupils with and without improved water supply, 25.0% and 29.0% respectively never took any snack. Fewer pupils with improved water supply did not take snacks compared to those without improved water supply. There was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to not taking snacks (Table 4.5).

According to the findings, of pupils with and without improved water supply, 8.0% and 5.0% respectively took ugali made from maize meal for lunch. Of pupils with and without improved waters supply, 3.0% and 2.0% respectively had rice for lunch. Of pupils with and without improved water supply 86.0% and 87.0% respectively, ate maize and beans (*Isyo)* for lunch. In addition, of pupils with and without improved water supply, 20.0% and 24.0% respectively ate Irish potatoes for lunch. Of pupils with and without improved water supply, 20.0% and 24.0% respectively consumed sukuma wiki (*Kales*) at lunch time (Table 4.5).

According to the findings, of pupils with and without improved water supply, 70.0% and 76.0% respectively, ate cabbages at lunch time. Fewer pupils with improved water supply ate cabbage than pupils without improved water supply.

There was a significant difference between pupils with improved water supply and those without with respect to consumption of cabbage at lunch time. According to the findings, there were pupils who never took lunch due to either the school did not offer relief food and there was no food for pupils to carry lunch from home or pupils were unable to go home for lunch due to too long distances (Table 4.5).

According to the findings, during super time just like during the previous meals, pupils with and without improved water supply consumed different types of food. Of pupils with and without improved water supply, 30.0% and 26.0% respectively ate ugali for supper. More pupils with improved water supply ate ugali for super than those without improved water supply. There was therefore a significant difference ($P < 0.05$) between pupils who had improved water supply and those without improved water supply with respect to consumption of Ugali at supper time.

Of pupils with and without improved water supply, 4.0% and 2.0% respectively ate rice for supper. Pupils with improved water supply who ate rice were slightly more than those without improved water supply. Of pupils with and without improved water supply, 66.0% and 72.0% respectively ate maize and beans (*Isyo*)) for supper. Fewer pupils with improved water supply ate maize and beans (Isyo) for supper compared to those without improved water supply. There was a significant difference ($P <0.05$) between pupils with improved water supply and those without with respect to consumption of maize and bean (Isyo).

Table 4.5: Types of food and number of meals consumed by pupils with and without improved water supply per day

Food item consumed	N(%) W	N(%) NW	P-Value
Breakfast			
Tea with milk	82 (41.0)	80 (40.0)	0.976
Black tea	16(3.0)	8 (4.0)	0.963
Porridge	6(3.0)	10 (5.0)	0.977
Milk	4 (2.0)	2 (1.0)	0.978
Bread	82 (42.0)	80 (40.0)	0.978
Ugali (from maize flour)	6(3.0)	4 (2.0)	0.978
Sukuma wiki(*kales*)	4 (2.0)	6 (3.0)	0.978
Maize and beans(*Isyo*)	8 (4.0)	10 (5.0)	0.978
Snacks			
Sugarcane	20 (10.0)	24 (12.0)	0.920
Tea with milk	8 (4.0)	4 (2.0)	0.921
Porridge	60 (30.0)	40 (20.0)	0.001
Ripe bananas	24 (12.0)	30 (15.0)	0.950
Mangoes	30 (15.0)	34 (17.0)	0.950
Bread	8 (4.0)	10 (5.0)	0.981
No snacks	50 (25.0)	58 (29.0)	0.040
Lunch			
Ugali (from maize flour)	16 (8.0)	10 (5.0)	0.961
Rice	16(3.0)	4 (2.0)	0.997
Maize and beans(*Isyo*)	172 (86.0)	174 (87.0)	0.991
Irish potatoes	40 (20.0)	48 (24.0)	0.040
Sukuma Wiki (*Kales)*	40 (20.0)	44 (22.0)	0.981
Cabbage	140 (70.0)	152 (76.0)	0.030
No food	6 (3.0)	12 (6.0)	0.678
Supper			
Ugali	60 (30.0)	52 (26.0)	0.040
Rice	8(4.0)	4 (2.0)	0.961
Maize and beans (*Isyo*)	132 (66.0)	144 (72.0)	0.010
Sukuma Wiki (*Kales*)	48(24.0)	44 (22.0)	0.993
Meat	12 (6.0)	14 (7.0)	0.993
Beans	10 (5.0)	6 (3.0)	0.614

W-With improved water supply NW-No improved water supply

Of pupils with and without improved water supply, 24.0% and 22.0% respectively ate sukuma wiki (kales) during super time. Of pupils with and without improved water supply, 6.0% and 7.0% respectively ate meat for supper. Finally of pupils with and without improved water supply, 5.0% and 3.0% had beans for supper. There was no significant difference ($P > 0.05$) Of pupils with and without improved water supply with respect to food eaten by pupils (Table 4.5).

4.2.2 Intake of energy and nutrients based on 24 hour dietary intake of pupils aged 6-13 years

Estimates percent energy and nutrient intake was determined and presented (Table 4.6).The findings showed that, nutrient intake Of pupils with and without improved water supply did not meet the required threshold. The energy intake was not met for pupils with (44.2%) and without (42.8) improved water supply respectively. Carbohydrates intake was also below the threshold for pupils with (78.8%) and without (72.0%) improved water supply with respect to dietary intake. Intake of protein for pupils with improved water supply (85.9%) and without improved water supply (84.1%) was below the required threshold. Intake of fat for pupils with improved water supply (42.0%) and without improved water supply (39.7%) was below the threshold. Same applied to the intake of iron where pupils with (86.2%) and without (81.1%) improved water supply, had intake below required quantity (Table 4.6).

According to the findings, iodine intake for pupils with improved water supply (87.1%) and without improved water supply (86.4%) was below the required quantity. Vitamin A intake for pupils with improved water supply (86.7%) and without improved water supply (88.3%), was below the required threshold. Thiamine intake for pupils with improved water supply (44.3%) and without improved water supply (41.7%) was below the required threshold. Riboflavin intake for pupils with improved water supply (45.2%) and without improved water supply (42.6%), was below the required threshold.

Niacin intake for pupils with improved water supply (43.0%) and without improved water supply (44.2 was below the required threshold.

Table 4.6: Intake of energy and nutrients based on 24-hour dietary intake of pupils aged 6 - 13 years

Nutritional Parameters	RNI	mean	±SD	Nutrient intake (%)	Mean	±SD	Nutrient intake %	P-Value
		W			NW			
Energy (Kcal)	1950-2400	950	612.5	44.2	930	622.5	42.8	0.746
Carbohydrates (g)	130	98.5	15.1	76.8	93.5	16.3	72.0	0.004
Total fibre	31.0	12.2	9.4	42.6	12.0	9.5	38.7	0.832
Protein (g/d)	34.5-44.2	33.8	2.8	85.9	32.3	3.5	84.1	0.000
Fat (g)	60.0	25.2	17.4	42.0	23.8	18.1	39.7	0.431
Iron (mg)	14-15	12.5	1.0	86.2	12.2	1.2	81.1	0.007
Iodine (mg)	150.0	130.6	9.7	87.1	129.7	10.5	86.4	0.374
Vitamins A(RE)	600	520.6	39.7	86.7	530	35	88.3	0.012
Thiamine (mg)	1.1-1.2	0.51	0.32	44.3	0.48	0.34	41.7	0.364
Riboflavin (mg)	1.0-1.3	0.52	0.32	45.2	0.49	0.33	42.6	0.357
Niacin (mg)	17.2	7.4	4.9	43.0	7.6	4.8	44.2	0.680
Folate (μg)	400	180.1	109.9	45.0	179.5	110.3	44.9	0.957
Vitamin C (mg)	40	17.5	11.3	43.8	16.9	11.6	42.3	0.601
Calcium	1300	620.2	339.9	47.7	615.8	342.1	47.4	0.897
Phosphorus	1250	605.1	322.5	48.4	608.2	320.9	48.7	0.923
Zinc	7.8-9.2	3.6	2.5	42.6	3.9	2.3	45.9	0.212

W-With improved water supply   NW-No improved water supply

Folate intake for pupils with (45.0%) and without (44.9%) improved water supply was below the requirement (Table 4.6).

Findings showed that vitamin C intake for pupils with improved water supply (43.8%) and without improved water supply (42.3%) did not meet the required quantity. Calcium intake for pupils with improved water supply (47.7%) and pupils without improved water supply (47.4%), did not met the required threshold. Phosphorus intake was of pupils with (at 48.4%) and without (at 48.7%) improved water supply was also below the threshold. Zinc intake of pupils with (42.6%) and without (45.9%) improved water supply, was below the threshold. Based on the findings, nutrient intake of pupils with and without improved water supply was below the threshold. However, there was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to carbohydrates and iron intake nutrient intake (Table 4.6).

4.3 Food consumption practices of pupils aged 6-13 years in Yatta Sub County

4.3.1 Sources of food consumed by the pupils

Food consumed by the pupils aged 6-13 years was purchased mainly from at the local market place. Of pupils with and with improved water supply, 93.0%) and 92.8.0% respectively, their households food source was mainly purchased from the market. Of pupils with and without improved water supply 4.5% and 5.0% their household sourced for food from their own farms. The food included milk, pawpaws, mangoes, green peas and yams (nduma). Of pupils with and without improved water supply, 2.5% and 2.0% respectively, their households depended on relief as a source of food. Schools that did not receive relief food, pupils carried packed lunch or stayed without food until when they returned to their homes in the evening (Table 4.7).

Table 4.7: Main sources of food consumed by pupil age 6-13 years with and without improved water supply in Yatta Sub County

Characteristics Source of food	W N(%) N=200	NW N(%) N=200	P-value
Market(Purchased)	186(93%)	185(92.5%)	0.091
Farm	9(4.5%)	11(5.5%)	0.898
Relief	5(2.5%)	4(2%)	0.988

W-With improved water supply NW-No improved water supply

According to the findings there was no significant difference (P > 0.05) between pupils from schools with improved water supply and those without improved water supply in respect to where food sourced (Table 4.7).

4.3.1.1 Sources of lunches and snacks for pupils aged 6-13 years in Yatta Sub County

Schools that received relief food provided pupils with both snacks (10.00 am o'clock porridge) and lunch (a mixture of maize and beans). Majority of pupils aged 6-13 years in day primary schools depended on relief for their lunches and 10.00 o'clock tea. Of pupils with and without improved water supply, 70.5% and 70.0% respectively depended on school relief food for their lunch (Table 4.8).

Table 4.8: Food consumption practices: lunch and snacks of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Sources of lunch	W N=200 N(%)	NW N=200 N(%)	P-value
Packed lunch	20(10%)	23(11.5)	0.628
Home lunch	31(15.5%)	30(15%)	0.889
School relief food	141(70.5%)	140(70%)	0.913
No snack& lunch	7(3.4%)	8(3.5%)	0.958

W-With improved water supply NW-No improved water supply**.**

Of pupils with and without improved water supply 15.5% and 15.0% respectively, went home for lunch. In addition of pupils with and without improved water supply, 10.0% and 11.5% carried packed lunch from home. Of pupils with and without improved water supply, 3.4% and 3.5% ate no snacks or lunch (Table 4.8). There was no significant difference (P > 0.05) between pupil who had improved water supply and those who did not have with respect to lunch and snacks consumption practices (Table 4.8).

4.3.2 Perception on pupils' dietary intake

The perceived findings revealed by FGDs, showed that most of the pupils experienced inadequate dietary intake. According to the findings, of pupils with and without improved water supply, 91.0% and 90.9 % respectively, their household members reported that they experienced inadequate dietary intake. Of pupils with and without improved water supply, equal percentage (1.6%) had adequate dietary intake (Table 4.9).

Table 4.9: Perception on pupils' dietary intake

Characteristics	(N=200) W N (%)	(N=200) NW N(%)	P-value
Adequate dietary intake	3(1.6)	3(1.7)	1.000
Inadequate dietary intake	182(91.0)	182(90.9)	1.000
None respondent	15(7.4)	15(7.5)	1.000

W-With improved water supply NW-No improved water supply

Of pupils with and without improved water supply, 7.4% and 7.5% respectively, none of their household members responded with respect to dietary quantity. There was no significant difference (P > 0.05) between pupils with improved water and those without improved water supply with respect quantity of dietary intake (Table 4.9).

4.3.3 Frequency of food consumption by pupils aged 6-13 years in Yatta Sub County

The food consumed was categorized into cereals, pulses and vegetables and fruits. Frequency of consumption of food depends on the number of times the food is consumed per week. Most of the pupils in the study, consumed cereals (91.8%) and pulses (97.0%) regularly. Of pupils with and without improved water supply 91.0% and 92.0% respectively consumed cereals regularly. In addition of pupils with and without improved water supply 96.0% and 98.0% consumed pulses regularly. There was no significant difference ($P > 0.05$) between pupils who had improved water supply and those who never had with respect to consumption of cereals and pulses. Otherwise the consumption of fruits, milk, fat and meat was irregular with respect to food consumption frequency (Table 4.10).

Animal products were consumed irregularly of pupils with improved water supply (2.0%) and those without improved water supply (2.5%). Of pupils with and without improved water supply, the same percentage (0.98%) of pupils consumed animal products regularly. Consumption of roots and tubers was irregular. Of pupils with and without improved water supply 95.0% and 94.0% respectively, consumed tubers and roots irregularly. (Table 4.10). Consumption of vegetables was regular. Of pupils with and without improved water supply 87.5% and 89.50% respectively, consumed vegetables regularly. Of pupils with and without improved water supply,12.50 and 10.50 respectively, consumed vegetables irregularly (Table 4.10).

Consumption of fruits of pupils with improved water supply (1 day per week) and without improved water supply (3 times per week) was irregular (Table 4.10). Of pupils with and without improved water supply, 89.0% and 82.0% respectively, consumed fruits irregularly. The findings revealed that of pupils with and without improved water supply, 10.0% and 18.0% respectively, consumed fruits regularly.

Table 4.10: Frequency of consumption of different food groups by pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Foodstuffs	W N=200	NW N=200	P-Value	W N=200	NW N=200	P-Value
	Irregularly (0-3) % n(%)			Regularly (4-7) n(%)		
Cereals	2(0.9)	15(7.5)	0.001	182(91.0)	185(92.5)	0.585
Animal products	4(2.0)	5(2.5)	0.736	2(0.98)	2(0.98)	1.00
Fat	173(86.5)	176(88.0)	0.653	27(13.50)	26(12.9)	0.883
Tubers/roots	190(95.0)	188(94.0)	0.661	10(5.00)	12(6.0)	0.661
Pulses	25(12.5)	21(10.5)	0.531	192(96.0)	196(98.0)	0.240
Vegetables	25(12.50)	179(10.5)	0.531	175(87.5)	179(89.5)	0.531
Fruits	179(89.5)	164(82.0)	0.031	21(10.50)	36(18.0)	0.031

W-With improved water supply NW-No improved water supply

Consumption: 4-7 days per week is regular, 0-3 days per week is irregular (Savage et al., 1992).

There was a significant difference (P < 0.05) between pupils with and without improved water supply with respect to consumption of fruits regularly and irregularly. Despite consumption of various foodstuffs either regularly or irregularly, there was no significant difference (P > 0.05) between pupils who had improved water supply and those who did not have with respect to food consumption frequency of most of the foods. However, there was a significant difference (P < 0.05) between pupils with and without improved water supply who consumed fruits with respect to food consumption frequency.

4.3.4. Proximate Composition of the main food (in 100g) consumed by pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Proximate composition of foods consumed by pupils was determined where food samples consumed by pupils from schools with & without improved water supply were collected and analyzed to establish the proximate food sample (AOAC, 2003). Of pupils with and without improved water supply, 55.7g and 55.7g respectively, was the moisture content with respect to 100g of *Isyo* (maize and beans). In the same food there was an equal amount (1.60g) of ash Of pupils with and without improved water supply. Of pupils with and without improved water supply 2.31g and 2.30 g respectively, of fat was found in 100g of *Isyo* (Maize and beans). Of pupils with and without improved water supply, 8.29g and 2.30g of carbohydrates respectively, was found in 100g of *Isyo* (maize and beans). Of pupils with and without improved water supply, 32.26g and 22.28g of protein respectively, was found in 100g of the same food Table 4.10. There was a significant difference ($P < 0.05$) between pupils with and without water supply with respect to carbohydrate and protein content of *Isyo* (Maize and bean).

Proximate composition of cooked beans was determined and it was found that of pupils with and without improved water supply, 85.11g and 85.10g of moisture respectively, was found in 100g of cooked beans that was sampled from each school. Of pupils with and without improved water, 1.06g and 1.05g of ash respectively was found in cooked beans. Of pupils with and without improved water supply, 0.60g and 0.61g of fat respectively, was found in cooked beans. Of pupils with and without improved water supply, 12.63g and 12.62g of carbohydrate respectively, was found in cooked beans. Of pupils with and without improved water supply, 0.60g and 0.61g of protein respectively, was found in the same cooked beans. There was no significant difference between pupils with and without improved water supply with respect to proximate nutrient content in cooked beans (Table 4.11).

Proximate composition of raw dried beans was determined as confirmation of the results on cooked beans proximate composition. Of pupils with and without improved water supply, 15.4g and 15.3g of moisture respectively, was found in dried raw beans. Of pupils with and without improved water supply, 0.99g and 0.88g of ash respectively, was found in raw dried beans. Of pupils with and without improved water supply, 0.81g and 0.85g of fat respectively, was found in dried raw beans. Of pupils with and without improved water supply, 14.0g and 14.10g carbohydrates respectively, was found in raw dried beans. Of pupils with and without improved water supply, 69.27g and 69.28g of protein respectively, was found in the same raw dried beans. There was no significant difference between pupils with and without improved water supply with respect to proximate nutrient content found in raw dried beans (Table 4.11).

Proximate composition of maize flour was determined as confirmation of results on ugali proximate composition that pupils were fed on. Of pupils with and without improved water supply, 12.14g and 12.15g of moisture respectively, was found in maize flour. Of pupils with and without improved water supply, 1.30 and 1.31g of ash respectively, was found in maize flour. Of pupils with and without improved water supply, 0.16g and 1.18g of fat respectively, was found in maize flour. Of pupils with and without improved water supply, 70.4g and 72.6g carbohydrates respectively, was found in maize flour. Of pupils with and without improved water supply, 5.9g and 8.5g of protein respectively, was found in the same maize flour. There was no significant difference between pupils with and without improved water supply with respect to proximate nutrient content found in maize flour.

Proximate composition of raw dried maize seeds was determined as a confirmation of a mixture of maize and beans proximate composition that pupils were fed on. Of pupils with and without improved water supply, 14.04g and 14.06g of moisture respectively, was found in raw dried maize seeds. Of pupils with and without improved water supply, 1.30 and 1.31g of ash respectively, was found in raw dried maize seeds. Of pupils with and without improved water supply, 1.16g and 1.19g of fat respectively, was found in raw dried maize seeds. Of pupils with and without improved water supply, 69.6g and 67.2g carbohydrates respectively, was found in raw dried maize seeds. Lastly of pupils with and without improved water supply, 6.7g and 7.2g of protein respectively, was found in the same raw dried maize seeds. There was no significant difference ($P > 0.05$ between pupils with and without improved water supply with respect to proximate nutrient content found in raw dried maize seeds (Table 4.11).

Proximate composition of milk tea was determined and of pupils with and without improved water supply, 93.31g and 93.33g of moisture respectively, was found in milk tea. Of pupils with and without improved water supply, 0.47g and 0.49g of ash respectively, was found in ugali (Table 4.11).Of pupils with and without improved water supply, 0.25g and 0.30g of fat respectively, was found in milk tea. Of pupils with and without improved water supply, 2.78g and 2.77g carbohydrates respectively, was found in milk tea. Of pupils with and without improved water supply, 3.32g and 3.35g of protein was found in the same milk tea. There was no significant difference between pupils with and without improved water supply with respect to proximate nutrient content found in milk tea.

Proximate composition of ugali was determined and of pupils with and without improved water supply, 31.05 and 31.06 of moisture respectively, was found in milk tea. Of pupils with and without improved water supply, 0.53g and 0.51g of ash respectively was found in ugali. Of pupils with and without improved water supply, 2.72g and 2.73g of fat respectively, was found in ugali. Of pupils with and without improved water supply, 62.5g and 63.9g carbohydrates respectively, was found in ugali. Of pupils with and without improved water supply, 6.8g and 7.7g of protein was found in the same ugali. There was no significant difference between pupils with and without improved water supply with respect to proximate nutrient content found in ugali.

Table 4.11: Proximate composition of the main foods (in 100g) consumed by pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Sample	Moisture (g/ 100g)		P-value	Ash (g/ 100g)		P-value	Fat (g/ 100g)		P-value	Carbohydrates (g/ 100g)		P-value	Protein (g/ 100g)		
	W N=200	NW N=200	P-value	W N=200	NW N=200	P-value	W N=200	NW N=200	P-value	W N=200	NW N=200	P-value	W N=200	NW N=200	P-value
***Isyo* (cooked maize & beans)**	55.70	55.69	0.951	1.60	1.61	0.97	2.31	2.30	0.99	8.29	2.30	0.32	32.26	22.28	0.021
Cooked beans	85.11	85.10	0.971	1.06	1.05	0.98	0.60	0.61	0.99	12.63	12.62	0.99	0.60	0.61	0.98
Raw beans (dried)	15.04	15.03	0.99	0.88	0.87	0.97	0.81	0.85	0.98	14.00	14.10	1.00	69.27	69.28	0.99
Maize flour	12.14	12.15	0. 981	0.70	0.71	0.99	2.11	2.12	0.99	70.4	72.6	0.94	5.9	8.5	0.97
Raw maize seeds (dried)	14.04	14.06	0.960	1.30	1.33	0.96	1.16	1.19	0.08	69.6	67.2	0.93	6.7	7.2	0.96
Milk Tea	93.31	93.33	0.981	0.47	0.49	0.98	0.25	0.30	0.98	2.78	2.77	0.99	3.32	3.35	0.96
Ugali	31.05	31.06	0.98	0.53	0.51	0.97	2.72	2.73	0.98	62.5	63.9	0.91	6.8	7.7	0.99

W-With improved water supply NW-No improved water supply Values are means ± SD of analyses.

According to the findings above, Statistical analysis, using ANOVA, shows that no significant difference exists between the values of the nutrient content of the products pupils with and without improved water supply consumed except moisture at $P < 0.05$ (Table 4.11).

4.3.5 Food consumption shortage coping mechanisms of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Food shortage coping mechanism was classified based on Household Food Insecurity Access Scale (HFIAS) where households were classified as having adequate food access, a mild food access deficit (less severe), a moderate food access deficit (moderate severe) and a severe food access deficit (severe). Coping mechanisms were classified as critical and non critical. During food shortage under non critical conditions, there were households where of pupils with and without improved water supply, 22.5% and 22.0%, respectively, had distress migration. Under same condition there were households where of pupils with and without improved water supply, 24.0% and 23.0% respectively, borrowed grain or cash from neighbours to cope with food shortage.

Under non critical conditions, of pupils with and without improved water supply, 3.5% and 4.5% respectively, their household members borrowed grains or cash from relatives. Further under non critical conditions, of pupils with and without improved water supply, 9.0% and 10.0% respectively, their household members reported that they changed cropping patterns. The same sentiments were confirmed by the Focus Group Discussion (FGDs) (Table 4.12).According to the findings, of pupils with and without improved water supply, 12.5% and 13.0% respectively, their household members reported that they sold firewood and charcoal to cope with the non critical situation. Under same condition, of pupils with and without improved water supply, 5.5% and 6.5% respectively, their household members reported that they leased out land to cope with the situation.

Table 4.12: Food Shortage coping Strategies of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Coping strategies	W N=200 N(%)	NW N=200) N(%)	P-Value
Non critical			
Distress migration	45(22.5%)	44(22.0%)	0.904
Borrow grain or cash from the neighbours	48(24.0%)	46(23.0%)	0.814
Borrow grains or cash from relatives	7(3.5%)	9(4.5%)	0.610
Changing cropping patterns	19(9.0%)	20(10.0%)	0.866
Firewood and charcoal selling	25(12.5%)	26(13.0%)	0.881
Lease out land	11(5.5%)	13(6.5%)	0.674
Rely on relief grains	8(4.0%)	7(3.5%)	0.804
Critical			
Livestock disposal or destocking	5(2.5%)	4(2.0%)	0.736
Sell off farm oxen	21(10.5%)	22(11.0%)	0.872
Sell off land	10(5.0%)	9(4.5%)	0.804

W-With improved water supply NW-No improved water supply

Significance was at $P > 0.05$

Pupils with and without improved water supply, 4.0% and 3.5% respectively relied on relief food to cope with same condition (Table 4.12). According to the findings, during critical condition, of pupils with and without improved water supply, 2.5% and 2.0% respectively, their household members reported that they destocked livestock as coping mechanism. In addition, there were households where of pupils with and without improved water supply, 10.5% and11.0% respectively, reported that they sold farm oxens to cope with critical condition. Under the same condition, there were households where of pupils with and without improved water supply, 5.0% and 4.5% respectively, opted to sell of land to cope with severe food shortage (Table 4.12). The above sentiments were confirmed by FGDs as true. According to the study findings, there was no significant difference ($P > 0.05$) of pupils with and without improved water supply with respect to food shortage coping mechanism (Table 4.12).

4.3.6 Food consumption practices of pupils aged 6-13 years with and without improved water supply and household members engagement in farming and non-farming activities

Most of the pupils with and without improved water supply, 96.5 and 97.0% respectively their household members were engaged in non-farming activities to bridge food shortage. Of pupils with and without improved water supply 2.5% and 1.5% respectively, their household members admitted having engaged in farming activities to bridge food shortage. Further of pupils with and without improved water supply 1.0% and 1.5% respectively their household members were non respondents (Table 4.13).

Table 4.13: pupils aged 6-13 years with and without improved water supply whose household members are engaged in farming and non-farming activities

Response for farm activities	W N=200 pupils N(%)	NW N=200 pupils N(%)	P-Value
Engaged in non-farming	193(96.5%)	194(97%)	0.778
Engaged in farming	5(2.5%)	3(1.5%)	0.475
Non respondent	2(1.0%)	3(1.5%)	0.653

W-With improved water supply NW-No improved water supply

Significance was at $P > 0.05$

The above sentiments were confirmed by the FGDs. There was no significant difference ($P > 0.05$) of pupils with and without improved water supply with respect to engagement in farming activities and non-farming activities.

4.3.7 Perceived causes of pupils aged 6-13 years with and without improved water supply insufficient food consumption

Focus Group Discussions showed that pupils with and without improved water supply, 97.5% and 98.0% respectively, their household members stated that inability to produce sufficient food crops as the cause of 'insufficient food consumption. Of pupils with and without improved water supply, 1.5% and 1.0% respectively, their household members gave a reason of inability to rear sufficient number of livestock as the cause of experiencing inadequate dietary intake. Further, of pupils with and without improved water supply, 1.5% and 1.0% respectively, their household members stated that exposure to 'insufficient food consumption was attributed to meagre income from non-farm activities (Table 4.14). The above sentiments that were given in regards to the cause of insufficient food consumption by household members were confirmed by the Focus Group Discussions as true.

Table 4.14: Perceived causes of pupils aged 6-13 years with and without improved water supply insufficient food consumption

Reasons for household insufficient food	W N=200 N(%)	NW N=200 N(%)	P-Value
Inability to produce sufficient food crops	195(97.5%)	196(98%)	0.736
Inability to rear sufficient number of livestock	3(1.5%)	2(1.0%)	0.653
Meagre income from non-farm activities	3(1.5%)	2(1.0%)	0.653

W-With improved water supply NW-No improved water supply

Significance was at $P > 0.05$

There was no significant difference ($P > 0.05$) of pupils with and without improved water supply with respect to causes of their' insufficient food consumption (Table 4.14).

4.3.8. Perceived effect of insufficient improved water supply on pupils' food consumption practices

Most pupils with and without improved water supply 68.5% and 69.9% respectively, their household members reported that insufficient water supply caused low agricultural productivity and production due to insufficient water supply. In addition pupils with and without improved water supply, 9.5 and 9.0% respectively, their household members reported that insufficient improved water supply affected the health of household members and food utilization**.** Of pupils with and without improved water supply, 7.5% and 8.5 % respectively, their household members reported that it took too much time and energy in searching for water (Table 4.15).

Table 4.15: Perceived effect of insufficient improved water supply on pupils' food consumption practices

Effect of insufficient water supply	N=200 W N(%)	N=200 NW N(%)	P-Value
Low agricultural productivity and production	137(68.5%)	138(69.9%)	0.194
Affecting health of household members and food utilization	19(9.5%)	18(9.0%)	0.866
Taking too much time and energy in fetching water	14(7.5%)	15(8.5%)	0.814
Vulnerability to drought and erratic rainfall distribution	16(8.0%)	15(7.5%)	0.852
Induced conflict over water use	13(6.5%)	14(7.0%)	0.842

W-With improved water supply NW-No improved water supply

Significance was at P > 0.05

Further of pupils with and without improved water supply, 8.0% and 7.5% respectively, their household members reported that insufficient water supply caused vulnerability to drought and erratic rainfall distribution hence causing of pupils with and without improved water supply, 6.5% and 7.0% respectively, their household members reported that Insufficient water supply also induced conflict over water use (Table 4.15). g inadequate food consumption. The same sentiments were confirmed by the FGDs as true.

All the reasons that were given in regards to the effect of insufficient water supply were confirmed as true by the FDGs. According to the findings, there was no significant difference ($P > 0.05$) of pupils with and without improved water supply with respect to the effect of insufficient water supply on pupils' food consumption practices (Table 4.15).

4.3.9 Perceived effect of improved water supply (presence of boreholes, dams and Water tanks) on pupils' food consumption practices

Most household members were in agreement that improved water supply would generally have a positive impact on food consumption practices. According to the findings, pupils with and without improved water supply 68.5% and 69.0% respectively, their household members reported that improved water supply (presence of boreholes, dam and rain water harvesting) would allow agricultural intensification through irrigation and improve hygiene and sanitation and of pupils hence limiting morbidity rates and improving food consumption of pupils (Table 4.16). In addition, Of pupils with and without improved water supply 14.0% and 15.0 % respectively, their household members were in agreement that improved water supply would lead to Improved health for family members. The same sentiments were confirmed by FGDs (Table 4.16).

Further of pupils with and without improved water supply, 8.5% and 9.0% respectively, their household members were in agreement that improved water supply would improve livestock productivity for improvement of pupils' food consumption practices (Table 4.16).

Table 4.16: Perceived effect of improved water supply (presence of boreholes, dams and rain water harvesting) on pupils' food consumption practices

Effect of improved water supply	N=200 NW	N=200 NW	P-Value
Allowed agricultural intensification through irrigation	137(68.5%)	138(69.0%)	0.914
Improved health for family members	29(14.0%)	30(15.0%)	0.888
Improved livestock productivity	17(8.5%)	18(9.0%)	0.860
Diversified sources of income	9(4.5%)	7(3.5%)	0.610
Increased income in absolute terms	8(4.0%)	7(3.5%)	0.792

W-With improved water supply NW-No improved water supply

According pupils with and without improved water supply 4.5% and 3.5% respectively, their members were in agreement that improved water supply would diversify sources of income. In addition pupils with and without improved water supply, 4.0% and 3.5% respectively, were household in agreement that improved water supply would increase income in absolute terms (Table 4.16). All above sentiments given in regards to perceived effect of improved water Supply (presence of boreholes, dams and rain water harvesting) pupils' food consumption were confirmed by the FGDs as true. There was no significant difference ($P > 0.05$) of pupils with and without improved water supply with respect to effect of improved water supply on consumption practice of pupils (Table 4.16).

4.4 Effect of improved water supply (presence of boreholes, dams and rain water (harvesting) on nutritional status of pupils aged 6-13 years in Yatta Sub County

4.4.1 Distribution of pupils studied by age and sex

Of pupils who participated in the study, the number per age group varied depending on the total number of each age group in each school, as stipulated in the table below (Table 4.17).

Table 4.17: Distribution of pupils studied by age and sex

Age group	No. of pupils N(%)	Male	Female
6-7	125 (31.3)	70 (56.0)	55 (44.0)
8-9	120 (30.0)	74 (61.0)	46 (38.0)
10-11	80 (20.0)	32 (40.0)	48 (66.0)
12-13	75 (18.8)	24 (32.0)	51 (68.0)
Total	400 (100)	200 (50)	200 (50)

Pupils' distribution was summarized along age groups as shown above (Table 4.17).

4.4.2 Weight, height and Body Mass Index for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

According to the study findings, of pupils aged 6-10 years with and without improved water supply, mean weight of 23.1kg and 20.5kg respectively, were determined. Comparing indicators in regards to pupils with and without improved water supply, it was evident that pupils with improved water supply were slightly heavier than those without improved water supply. There was a significant difference between pupils with and without improved water supply with respect to weight. Of the same pupils aged 6-10 years with and without improved water supply, a mean of 124.0 cm and 122.5cm respectively, were determined with respect to pupils' height.

Comparing indicators therefore pupils with improved water supply were slightly taller than those without improved water supply. There was a significant difference (P < 0.03) between pupils with improved water supply and those without improved water supply with respect to height. Of pupils 6-10 years with and without improved water supply, BMI mean of 14.8 (Kg/m^2) and 13.7 (Kg/m^2) respectively, were determined. There was no significant difference between pupils aged 6-10 years with improved water supply and those without with respect to BMI (Table 4.18).

Table 4.18: Weight, height and Body Mass Index of pupils aged 6-10 years with and without improved water supply in Yatta Sub County

			6-10 years			
		W		**NW**		
Measurements	**STD mean**	**Mean**	**±SD**	**Mean**	**±SD**	**P-Value**
Weights (kg)	26.5	23.0	3.2	20.5	6.2	0.04
Heights (cm)	129.5	124.4	5.3	122.5	7.4	0.03
BMI (kg/m^2)	15.9	14.8	1.3	13.7	2.3	0.08
			11-13 years			
BMI (kg/m^2)	18.9	16.4	2.6	15.2	3.8	0.07

W-With improved water supply NW-No improved water supply

There was a significant difference (P < 0.05) between pupils aged 6-10 years with and without improved water supply with respect to their mean weight and height. However there was no significant of the same pupils with respect to BMI. (Table 4.18).

Of pupils aged 11-13 years , with and without improved water supply, BMI of 16.4 (Kg/m^2) and 15.2 (Kg/m^2) respectively, were determined. There was no significant difference (P = 0.07) between pupils with and without improved water supply with respect to BMI of pupils aged 11-13 years .

4.4.3 Comparison of pupils with and without improved water supply with respect to weight, height and Body Mass Index (BMI) by gender

According to the findings, of male pupils with and without improved water supply, mean weight of 23.1kg and 21.0 kg respectively, were determined. Pupils with improved water supply had higher mean weight compared to the pupils without improved water supply. There was a significant difference (P-Value =0.040) between pupils with and without improved water supply with respect to the mean weight of male pupils aged 6-13 years. Of pupils with and without improved water supply, mean height of 124.4 cm and 122.8 cm respectively, were determined. Male pupils with improved water supply had a higher mean height compared to those without improved water supply (Table 4.19). There was a significant difference ($P < 0.031$) between male pupils with improved water supply and those without with respect to mean of the height.

Of male pupils aged 6-10 years with and without improved water supply, Body Mass Index mean of 14.9 (Kg/m^2) and 13.9 (Kg/m^2) respectively, were determined. Pupils with improved water supply had a slightly higher BMI mean compared to those without. However there was no significant difference between pupils with and without improved water supply with respect to BMI of male pupils (Table 4.19).

According to the findings, of female pupils aged 6-10 years with and without improved water supply, mean weight of 22.1 kg and 20.0 kg respectively, were determined. Pupils with improved water supply had a slightly higher mean weight compared to those without improved water supply. There was a significant difference (P-Value = 0.041) between pupils with and without improved water supply with respect to the mean weight of female pupils aged 6-13 years .

Table 4.19: Comparison of pupils aged 6-13 years with and without improved water supply with respect to weight, height and BMI by gender

6-10 years												
		Male pupils						Female pupils				
Measurements	**STD Mean**	**W mean**	**±SD**	**NW mean**	**±SD**	**P-Value**	**STD mean**	**W mean**	**±SD**	**NW mean**	**±SD**	**P-value**
Weight(kg)	26.5	23.1	3.8	21.0	3.2	0.040	25.2	22.1	3.7	20.0	3.1	0.041
Height(cm)	129.5	124.4	4.9	122.8	4.3	0.031	128.9	124.3	4.85	122.2	4.41	0.045
BMI (Kg/m^2)	15.9	14.9	1.46	13.9	1.06	0.085	15.2	14.3	1.42	13.5	1.05	0.085
11-13 years												
BMI (Kg/m^2)	18.9	16.1	1.48	15.9	1.2	0.081	18.4	16.7	1.5	14.5	2.4	0.074

W-With improved water supply NW-No improved water supply

Of female pupils with and without improved water supply, mean height of 124.3 cm and 122.2cm respectively, were determined. Female pupils with improved water supply had a higher mean height compared to the female pupils without improved water supply. There was a significant difference (P = 0.045) between female pupils with and without improved water supply with respect to the mean height of female pupils aged 6-10 (Table 4.19). Of female pupils with and without improved waters supply, BMI mean of 14.3 (Kg/m^2) and 13.5(Kg/m^2) respectively, were determined. There was no significant difference (P = 0.085) between pupils with and without improved water supply with respect to BMI mean of female pupils aged 6-10 years (Table 4.19).

According to the findings, of male pupils aged 11-13 years , with and without improved water supply, BMI mean of 16.1(Kg/m^2) and 15.9 (Kg/m^2) respectively, were determined. There was no significant difference (P = 0.081) between male pupils with and without improved water supply with respect to BMI. Of female pupils aged 11-13 years with and without improved water supply, BMI of 16.7 (Kg/m^2) and 14.5(Kg/m^2) respectively, were determined.

There was no significant difference (P > 0.074) between pupils with and without improved water supply with respect to BMI mean of female pupils aged 11-13 years (Table 4.19).

4.5 Morbidity rates of pupils aged 6-13 years with and without improved water Supply in Yatta Sub County

4.5.1 Observation Checklist results for Pupils aged 6-13 years with and without improved water supply in Yatta Sub County

4.5.1.1 Status of facilities and structures

Observation was divided into two main groups, facilities and structures and hygiene and healthy living categories. Of pupils with and without improved water supply, 85% and 80.0% respectively, used cemented structures (Table 4.20). More pupils with improved water supply used cemented structures compared to pupils without improved water supply. Further of pupils with and without improved water supply, 15% and 20.0% respectively, used earth floor. Fewer pupils with improved water supply used earth floors compared to pupils without improved water supply. More pupils of those with and without improved water supply, 86% and 82.0% respectively, used facilities that had brick walls. more pupils with improved water supply used buildings with bricks compared to those without improved water supply. Otherwise 100% pupils on either site used facilities that had iron sheet walls. Of pupils with and without improved water supply, 5.0% and 8.0% respectively, used structures with timber walls (Table 4.20).

Most pupils with (86.0%) and without (88.0%) improved water supply used building with dilapidated walls roofs and floors. There were slightly more pupils with improved water supply than those without used buildings with dilapidated walls and floors. Of pupils with and without improved water supply, 30.0% and 28% respectively, used building with leaking roofs. At the same time 70% of Pupils with improved water supply and 74% without improved water supply used buildings with dirty walls.

Of pupils with and without improved water supply, 34.0% and 40.0 % respectively, used buildings with cracked walls. Of pupils with and without improved water supply, 40.0% and 56.0 % pupils respectively, were in schools with strong walls and roofs of school buildings were observed (Table 4.20).

Of pupils with and without improved water supply, 46.0% and 40.0% respectively, used congested classrooms. Of pupils with and without improved water supply, 3.0% and 5.0 % respectively, used buildings with inadequate ventilation . Of pupils with and without improved water supply, 33.5% and 25.0% respectively, used school compounds that were bushy . According to the findings, all (100.0%) schools with and without improved water supply had toilets. However, of pupils with and without improved water supply, 40.0% and 33.0% respectively, had inadequate toilets. At the same time of pupils with and without improved water supply, 25.0% and 28.0% respectively, the classes they used were far from (100 meters) the toilet (Table 4.20).The same was confirmed by Key Informants Interviews. According to the Key Informants Interview, the status of facilities and structure in schools with and without improved water supply was required to be improved to enhance hygiene and sanitation.

Table 4.20: Status of facilities and structures of schools for pupils aged 6-13 years with and without improved water supply

Facilities, Structures and sanitation Classrooms and toilets	N=200 (%) W	N=200 (%) NW	P-Value
Construction materials			
Makuti	0(0.0)	0(0.0)	
Cement	170(85.0)	160(80.0)	0.187
Earth (floor)	30(15.0)	40(20.0)	0.187
Stone/Bricks, Blocks (Wall)	172(86.0)	164(82.0)	0.275
Iron Sheets (roof)	200(100)	200(100)	1.000
Timber (wall)	10(5.0)	16(8.0)	0.223
Condition of Walls, roofs, floor			
Dilapidated	172(86.0)	176(88.0)	0.552
Leaking roofs	60(30.0)	56(28.0)	0.659
Dirty walls	140(70.0)	148(74.0)	0.373
Clean walls	60(30.0)	52(26.0)	0.228
Walls with cracks	68(34.0)	80(40.0)	0.213
Strong roofs and walls	80(40.0)	112(56.0)	0.001
Spacious classrooms	108(54.0)	120(60.0)	0.225
Congested classrooms	92(46.0)	80(40.0)	0.225
Food service area available	126(63.0)	134(67.0)	0.401
Playing ground and environment Field			
Very bushy	66(33.0)	50(25.0)	0.077
Moderately bushy	30(15.0)	24(12.0)	0.380
Well kept	104(52.0)	126(63.0)	0.025
Ventilation			
Adequate	197(97.0)	190(95.0)	0.046
Latrine/toilet			
Present	200(100.0)	200(100.0)	1.000
Adequate	120(60.0)	134(67.0)	0.145
Very far from classes	50(25.0)	56(28)	0.496
Moderately far from classrooms	100(50.0)	104(52.0)	0.689
Near classrooms	50(25.0)	40(20.0)	0.230
Fire safety measures			
Fire extinguisher available	2(1.0)	4(2.0)	0.410
Fire alarm present	0(0.0)	0(0.0)	
Sand in buckets	10(5.0)	16(8.0)	0.223

W-With improved water supply NW-No improved water supply

Of pupils with and without improved water supply, 5.0% and 8.0% respectively, had sand in buckets in their respective schools as a safety measure respectively (Table 4.20).The same was confirmed by Key Informants Interviews.

4.5.1.2 Hygiene and health living for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

According to the study findings, garbage disposal was a challenge for most schools. All schools had pits where they deposited rubbish and burned them in the open. All (100) pupils with and without improved water supply were therefore, in schools that disposed rubbish in pits and burned them. Pupils collected litter with bare hands and took to the pits under supervision of their teachers (Table 4.21).The same was confirmed by Key informants.

All schools with and without improved water supply, had no garbage collection services. All (100.0%) pupils carried their own materials (tissues, newspapers, leaves) not necessarily toilet rolls for use after visiting the toilet (Table 4.21). Of pupils with and without improved water supply, 95.0% and 4.0% respectively, sourced water from boreholes. In addition, of pupils with and without improved water supply, 3.0% and 1.0% respectively, sourced water from water tanks. There was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to water sources. The above information was confirmed by Key Informants.

There was therefore a significant difference ($P = 0.00$) between pupils with and without improved water supply with respect to cleaning of classrooms and toilets. All (100.0%) pupils with and without improved water supply neither accessed soap for washing hands nor washing hands basin after visiting the toilet (Table 4.21).

Table 4.21: Hygiene and health living for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Hygiene and sanitation	N=200(%)W	N=200(%)NW	P-Value
Garbage disposal			
Pit	200 (100.0)	200(100.0)	1.000
Burning	200(100.0)	200(100.0)	1.000
Dust bin and waste paper baskets available	136(68.0)	140(70.0)	0.665
Dust bins ad waste paper baskets not available	64(32.0)	60(30.0)	0.665
Garbage collection services available	0(0.0)	0(0.0)	
Garbage collection services not available	200(100.0)	200(100.0)	1.000
Toilet rolls available	0(0.0)	0(0.0)	
Regular cleaning of classrooms and toilets	196(98.0)	156(78.0)	0.000
Water sources			
Piped water	6(3.0)	0(0.0)	0.013
Wells	0(0.0)	190(95.0)	0.000
Dams	(0.0)	2(1.0)	0.155
Boreholes	200(100.0)	8(4.0)	0.000
Water tanks	6(3.0)	2(1.0)	0.152
Soap available for washing hands	0(0.0)	0(0.0)	
Washing hands basin and stand available	0(0.0)	0(0.0)	
Drinking fountain buckets and cups in class	0.0	0.0	
Open drainages	60.0	65.0	0.003
Method of food storage			
Shelves	196(98)	190(95)	0.101
Refrigerator	0(0.0)	0(0.0)	
Deep freezer	0(0.0)	0(0.0)	
Sacks	190(95.0)	194(97)	0.30
Plastic tins	10(5.0)	6(3.0)	3.0

W-With improved water supply NW-No improved water supply

Of pupils with and without improved water supply, 40.0% and 35.0% respectively, were in schools with blocked drainage. All pupils with and without improved water supply did not have drinking fountain buckets and cups in class for drinking water. However, most pupils carried water for drinking in bottles from home.

According to the findings, of pupils with and without improved water supply, 98.0% and 95.0% respectively, were in schools that stored food on shelves. In addition of pupils with and without improved water supply, 95.0% and 97.0% respectively, were in schools that stored food in sacks. Further of pupils with and without improved water supply, 5.0% and 3.0% respectively, their schools stored food in plastic containers. None of pupils with or without improved water supply, their schools stored food neither in a refrigerator nor a freezer (Table 4.21).The same was confirmed by Key Informants.

According to the Key Informants Interviews, Improved water supply was vital in schools to enhance hygiene and health living.

4.5.2 Morbidity rates of pupils aged 6-13 years with and without improved water Supply in Yatta Sub County

4.5.2.1 Morbidity rates of pupils with and without improved water supply in Yatta Sub County

According to the findings, of pupils with and without improved water supply, 41% and 46.5% respectively, were sick (Table 4.22). The analysis therefore indicated that more pupils (46.5%) without improved water supply reported more incidences of sickness compared to the pupils with improved water supply (41%).

Table 4.22: Morbidity rates of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Characteristics Illness	W %(n)	NW % (n)	P-Value
Sick	41.0 (82)	46.5 (93)	0.013

W-improved water supply NW-No improved water supply

To ascertain the difference in the proportions reported by the two groups, a two sample t-test was conducted which yielded a P- value = 0.013, indicating that the magnitude of the difference between the two groups was statistically significant. There was therefore a significant difference ($P < 0.05$) in morbidity rates of pupils with and without improved water supply (Table 4.22).

4.5.2.2 Illnesses reported in the last one-month of pupils aged 6-13 years , with and without improved water supply in the three Divisions, in Yatta Sub County

Illness (morbidity) of pupils aged 6-13 years was determined Of pupils with and without improved water supply, in three Divisions of Yatta Sub County. In Ikombe Division, 85.4% of pupils, 92.7% had diarrhoea, 24.8% had difficulty breathing and 85.4 % had fever.

In Katangi Division the situation was different, 38.4% had colds, 25.6% had diarrhoea and 17.4 % had fever. In Yatta Division 35.2% had colds, 40.3% had diarrhoea and 30.1% had fever. Pupils had other infections apart from what has been mentioned above. In Ikombe Division, 2.4% had other infections while in Yatta it was 2.3% with other infections and Yatta Division it was 1.4% (Figure 4.1).

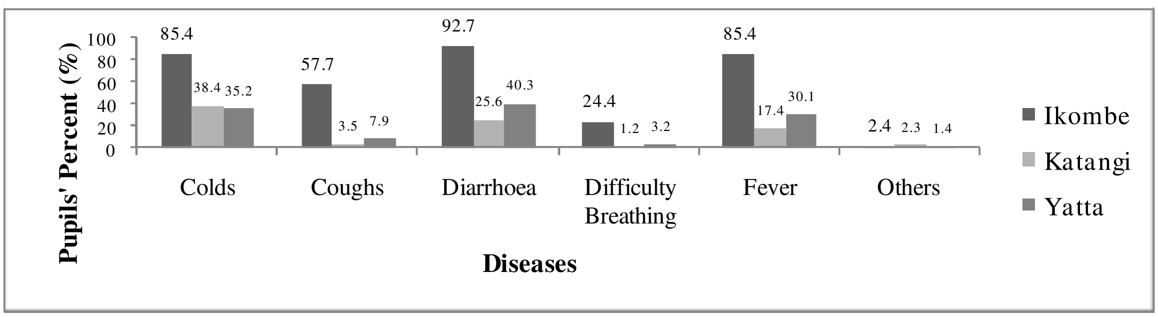

Figure 4.1: Illness (morbidity) of the pupils aged 6-13 years with and without improved water supply

According to the study findings, Ikombe Division was the most (97.7%) affected Division with respect to infections. There were also more malnutrition cases in Ikombe than other Divisions (Yatta and Katangi) (Figure 4.1).

4.5.2.3 Illnesses reported in the last one-month of pupils aged 6-13 years , with and without improved water supply in Yatta Sub County

Illness (morbidity) of pupils with and without improved water supply was determined in Yatta Sub County. As per the finding, of pupils with and without improved water supply, 26.2% and 27.6% respectively had colds. There was no significant difference (P > 0.05) between pupils who had improved water supply and those who did not with respect to infection. Further of pupils with and without improved water supply, 24.5% and 16.2% respectively had coughs.

More pupils of those who had improved water supply had coughs than those without improved water supply. There was a significant difference (P = 0.00) between pupils who had improved water supply and those who did not with respect to cough infection. According to the findings, of pupils with and without improved water supply, 21.5 and 25.0% respectively, had diarrhoea. More pupils with improved water supply than without improved water supply had diarrhoea (Table 4. 23).

Table 4.23: Illnesses reported in the last one-month of pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Illness	N=200 W N(%)	N =200 NW N(%)	P-Value
Colds	52(26.2)	55(27.6)	0.073
coughs	49(24.5)	32(16.2)	0.000
Diarrhoea	43(21.5)	50(25.0)	0.003
Difficulty breathing	10(4.9)	18 (9.0)	0.002
Fever	44 (21.9)	40(20.0)	0.610
Others	2 (0.9)	5(2.3)	0.074

W-With improved water supply NW-No improved water supply

There was a significant difference (P = 0.03) between pupils with and without improved water supply with respect to diarrhoea infection. Of pupils with and without improved water supply, 4.9% and 9.0% respectively, had difficulty breathing. Fewer pupils had difficulty breathing of pupils with improved water supply than those without improved water supply. There was a significant difference (P = 0.02) between pupils with and those without improved water supply with respect to difficulty breathing (Table 4.23). According to the findings, of pupils with and without improved water supply, 21.9% and 20.0% respectively, had fever. There was no significant difference (P = 0.610) between pupils with and those without improved water supply with respect to fever.

Of pupils with and without improved water supply, 0.9% and 2.3% respectively had other diseases (Table 4.23). Fewer pupils with improved water supply than those without improved water supply had other infections. However, there was no significant difference (P = 0.074) between pupils with and those without improved water supply with respect to other infections. There was a significant difference ($P < 0.05$) between pupils who had improved water supply and those who did not with respect to the percentage of pupils who were ill in Yatta Sub County (Table 4.23).

4.6. Relationship between variables

The relationship between variables was explored where modeling approach (regression), test of association (chi-square) and the correlational paradigm were adopted.

4.6.1 Regression between the nutritional status, the dietary intake and morbidity rate of pupils aged 6-13 years in Yatta Sub County

In the presence or absence of improved water supply, the nutritional status, dietary intake and morbidity rates were presumed to explore significant effects on the pupils aged 6-13 years.

The relationship between the dietary intake, morbidity rates and the nutritional status was determined. To examine this ideology, a regression analysis model with nutritional status and morbidity rates as the dependent variables while dietary intake presumed as the independent variable was carried out (Table 4.24).

Table 4.24: Model summary for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.752[a]	0.565	0.561	1.59772

a. Predictors: (Constant), morbidity rates, nutritional status

According to the results, the coefficient of determination (R^2) value 0.565 indicates that 56.5% of the changes in dietary intake can be explained by changes in the predictor variable (Nutritional status and the morbidity rates) while 43.5% of the changes in the model can be explained by other factors not studied in this research (Table 4.24).

Table 4.25: Model significance for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	653.117	2	326.559	127.926	.000[b]
	Residual	502.883	197	2.553		
	Total	1156.000	199			

a. Dependent Variable: Nutrition Status

b. Predictors: (Constant), morbidity rates, dietary Intake

To test for the overall significance of the model we formulate the hypothesis:

H_O: $\beta 1 = 0$ (model is not significant) Vs H_1: $\beta I \neq 0$ (model is significant)

The model significance assessment above depicts a p-value 0.001 which is less than α value 0.05. We therefore reject the null hypothesis and conclude that the model parameters are significantly different from zero hence the model is statistically significant and can be used for further analysis. In other words, the nutritional status significantly responds to dietary intake (Table 4.25).

4.6.2 Correlation coefficient for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

The results above revealed that, keeping dietary intake and the morbidity rates constant (at zero) the expected nutrition status level is rated at 4.144. One unit increase in dietary intake while the morbidity rate constant will lead to an increase of 0.446 in nutritional status (p-value 0.001 indicating statistical significance). A unit increase in the morbidity rates while keeping the dietary intake constant will result to a decrease of the nutrition status by -1.024 units (p-value 0.001 indicating statistical significance).

Table 4.26: correlation coefficient for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.144	.931		4.453	.000
	Dietary Intake	.446	.065	.361	6.878	.000
	Morbidity Rate	-1.024	.065	.744	15.761	.000

a. Dependent Variable: Nutrition Status

The estimated model is: Y (Nutrition Status)=4.144+0.446X_1(Dietary Intake) + 0.116X_2 (Morbidity Rate) + Σ(Error term)

Morbidity exhibit an inverse relationship between morbidity rates and the pupils' nutritional status. This indicates that dietary intake incrementally improved the prediction of nutritional status of pupils with and without improved water supply .

Evidently, the model perspective indicates that the pupils' nutritional status was inversely related to morbidity rate and directly to the pupils' dietary intake (Table 4.26).

4.6.3 Association between Parents' Education level and pupils' Morbidity Status in Yatta Sub County

To establish whether the assumption that parents education level was associated with morbidity rates, of pupils with and without improved water supply, a chi-square test for independence for the two groups was conducted (Table 4.30). The chi-square test yielded, χ^2 (3) = 342.46, p = .0.546 for the pupils with improved water supply. Since the $p > 0.05$ we do not reject the null hypothesis and conclude that there is no statistically significant association between the parents education level and the morbidity rate (Table 4.27).

Table 4.27: Association between Parents' Education level and pupils' Morbidity Status in Yatta Sub County

Chi-Square Tests						
	W			**NW**		
	Value	df	Asymp. Sig. (2-sided)	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	342.460[a]	3	0.546	4.914[a]	3	0.002
Likelihood Ratio	182.336	3	0.453	5.025	3	1.000
Linear-by-Linear Association	0.225	1	0.636	0.022	1	0.881
N of Valid Cases	318			311		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 22.54.

W-improved water supply   NW-No improved water supply

More so, for the pupils without improved water supply, the chi square test yielded χ^2 (3) = 4.914, p = 002. Since the $p < 0.05$ we reject the null hypothesis and conclude that there was a statistically significant association between the parents education level and the reported morbidity rates (Table 4.27).

4.6.3.1 Correlation between dietary intake, Morbidity rate and nutritional status of Pupils aged 6-13 years

Determination of the relationship between the variables was aimed at examining the magnitude and the fluctuation of the relationship that existed between the dietary intake, morbidity rate and the nutritional status of the pupils with and without improved water supply. A statistic was used to show how the scores from one measure relate to scores on a second measure for the same group of individuals. A high value (approaching +1.00) is a strong direct relationship, a low negative value (approaching -1.00) is a strong inverse relationship, and values near 0.00 indicate little, if any, relationship. To determine how dietary, morbidity rate and nutrition status were related the correlation test to establish the type of relationship and their respective direction was carried out (Table 4.28).

According to the findings there was a strong positive statistically significant correlation between nutritional status, the dietary intake and morbidity rate for the pupils with improved water supply. The correlation coefficients for these variables are dietary intake 0.628 ($p=0.02$) and morbidity rate 0.750 ($P=0.001$). Also, the study revealed that there was a positive correlation between dietary intake and morbidity rates 0.310 ($P=0.001$) of the pupils with improved water supply (Table 4.28).

Table 4.28: Correlation between dietary intake, Morbidity rate and nutrition status of Pupils aged 6-13 years with and without improved water supply in Yatta Sub-County

		W			NW		
		Nutrition Status	Dietary intake	Morbidity Status	Nutrition Status	Dietary Intake	Morbidity Status
Nutrition Status	Pearson Correlation	1	.628**	.750**	1	.728**	.810**
	Sig.(2-tailed)		.020	.000		.002	.000
	N	200	200	200	200	200	200
Dietary Intake	Pearson Correlation	.628**	1	.310**	.728**	1	.650**
	Sig.(2-tailed)	.020		.001	.002		.004
	N	200	200	200	200	200	200
Morbidity Rate	Pearson Correlation	.750**	.100	1	.810**	.650**	1
	Sig.(2-tailed)	.000	.310**		.000	.004	
	N	200	200	200	200	200	200

****. Correlation is significant at the 0.05 level (2-tailed).**

W-improved water supply NW-No improved water supply

According to the assessment of the same relationship, between the pupils with and without improved water supply, the study found that there was a statistically significant strong positive relationship between the nutritional status, dietary intake and morbidity rate of the pupils without improved water supply. The correlation coefficients for these variables are dietary intake 0.728 (P=0.02), morbidity rate 0.810 (P = 0.001) while the correlation coefficient between the morbidity rate and the dietary intake was 0.650 (P = 0.004) (Table 4.28).

The findings therefore revealed that there was a significant strong positive correlation between the nutritional status, dietary intake and morbidity rates of the pupils without improved water supply compared to those with improved water supply. Primarily, this implies that the presence or absence of improved water supply significantly influenced the morbidity rate, dietary intake and the nutritional status of pupils aged 6-13 years in mixed day primary schools in Yatta Sub County.

According to the findings, improved water supply had an effect on dietary intake, food consumption practices, nutritional status and morbidity rates of pupils aged 6-13 years with and without improved water supply. However improved water supply had no effect on pupils with and without improved water supply with respect to parents' Demographic and Socio-economic characteristics.

CHAPTER FIVE

DISCUSSION

5.1 Demographic and Socio-economic characteristics

Evaluation of the independent association of parental education on the nutritional status of the children using anthropometric measurements and body composition tools was carried out to establish the effect (Alalaq, 2014). In addition according to other studies, Health Education Programs could be effective for solving the undernutrition problem (Lahiru et al., 2017). This study is a confirmation of the above findings where a large percentage of pupils with and without improved water supply,79.0% and 78.5% respectively, their mothers had primary education level only. On the other hand in this study, of pupils with and without improved water supply 78.0 and 72.0% respectively, their fathers had the same education level. There is, therefore, need for efforts to be directed towards improvement of parental literacy level to alleviate malnutrition Of parents of pupils' aged 6-13 years. Otherwise, there was no significant difference (P > 0.05) between parents who had improved water supply and those who did not have with respect to education level.

Some of the research show that children and adolescents from low income families tend to consume less fruit and vegetables and more sugar, fats, processed meat, soft drinks, salty snacks compared with those from higher social class households (Skafida & Treanor, 2014). In addition, studies from different countries confirm these links and claim that prevalence of children and adolescents' unhealthy behavior including diet tend to be higher in families with low socio-economic position compared with high social class households (Skardal et al., 2014).This study is a confirmation of the above studies where families were engaged in various activities to enhance their social economic status, in order to alleviate malnutrition. For example, parents were engaged in various activities for their livelihood. For instance, a number (18.8%) of pupils their mothers were engaged in small businesses.

Of pupils with and without improved water supply, 18.5% and 19.0% respectively, their mothers were engaged in non sustainable businesses. The same was confirmed by one of the Key informants:

"I sell vegetables and sometimes I stop because the money is spent on food. I only resume selling vegetables when I go into a forest to burn charcoal and sell to buy more vegetables for selling" (Interviewed Women group chair lady representative, Yatta Division, March 2012).

None of the previous studies, have compared dietary intake, nutritional status and morbidity rates of pupils with and without improved water supply.

5.2 Effect of improved water supply on dietary intake of pupils aged 6-13 years in Yatta Sub County

World leaders have made several commitments to drastically reduce or eliminate hunger and Malnutrition and achieve sustainable food security for all. Progress continues, but at least 805 million people in the world still suffer from chronic hunger (FAO et al., 2014). According to other studies elsewhere, the effect of improved water supply on dietary intake has been positive. For example, access to safe drinking-water, sanitation and hygiene (WASH) services is a fundamental element of healthy communities and has an important positive impact on nutrition (WHO et al., 2015). This study confirms the effect of improved water supply on dietary intake.

According to the findings, Carbohydrates intake was below the threshold for pupils with (78.8%) and without (72.0%) improved water supply. The same applied to the intake of iron where pupils with (86.2%) and without (81.1%) improved water supply, had intake below required quantity. However, there was a significant difference ($P < 0.05$) between pupils with and without improved water supply with respect to carbohydrate and iron intake. Based on the findings, nutrients intake of pupils with and without improved water supply was below threshold.

This was attributed to the limited intake of required quantity of food and illness. In addition, given that Yatta Sub County is a Semi Arid region, accessibility of food was curtailed by harsh climatic conditions. Despite school feeding programme, still pupils were exposed to inadequate dietary intake caused by unreliable school feeding programme.

According to other studies, pathogenic environment temporarily affected pupils nutritional status and that a hygienic environment supported improved nutrition (Korpe & Petri, 2013). Causes of malnutrition include inadequate food intake, incorrect feeding practices, diseases or more frequent combination of these factors (WHO, 2016).This study is a confirmation of other studies where of pupils with and without improved water supply, 3.0% and 6.0% respectively had no lunch. In addition of pupils with and without improved water supply, 25.0% and 29.0% respectively had no snacks. Further according to the findings, of pupils with and without improved water supply, 2.0% and 22.0% respectively, never cleaned their classrooms and toilets regularly. Fewer pupils with improved water supply never cleaned their classrooms and toilets compared to those without improved water supply. Hence limited improved water supply is attributed to limited cleanliness, compromising hygiene and sanitation.

5.3 Food consumption practices of pupils with and without improved water supply

According to other study findings, pupils' dietary intake in the semiarid regions was challenging, exposing household members including pupils to malnutrition (FAO, 2014). Seasonality had a significant effect on food security with the situation becoming worse during the dry season. The change in dietary diversity, the number of meals consumed per day, the frequency of food consumption was an indicator of how seasons affect household food security and consumption pattern (Chege & Muthamia, 2016). According to this study, relief food was not reliable, a confirmation that there was dependence on unreliable food due harsh climatic conditions, not favourable for sustainable food production.

"Relief food is not reliable since at times it is received late or not received at all during the term"(Key informant-Interviewed one the of school heads in Katangi Division, February 2012).

Many of the schools supported through the school feeding program have considerable problems accessing clean water, adequate fuel supplies, and fruits and vegetables to supplement the basic school feeding program in targeted arid and Semi-Arid land areas (WFP, 2013.The findings of this study therefore, are a confirmation of studies stated above. For instance, of pupils with and without improved water supply, 91.0% and 92.5% respectively, had a regular consumption of cereals. However, consumption of fruits, milk, fat and meat was irregular with consumption being less than four times per week. There was no significant difference (P-value > 0.05) between pupils who had improved water supply and those who did not have with respect to consumption of foods either regularly or irregularly.

Of pupils with and without improved water supply 2.5% and 1.5% respectively, their household members admitted having engaged in farming activities to bridge food shortage. The same was confirmed as stated below through Key informant.

"*The fact that we are close to the water canal, we at times plant vegetables (Sukuma wiki) on small scale to sell and buy other foodstuffs. We also keep livestock which we depend on, for milk production" (*Key informant, Yatta Division, March 2012).

Of pupils with and without improved water supply, 68.8% and 69.9% respectively, their household members reported that improved water supply would allow agriculture intensification and hence improve family members healthy. The same was confirmed by the Focus Group Discussions (FGDs) in Yatta Sub County. This is a confirmation of the above stated studies.

5.4 Effect of improved water supply on nutritional status of pupils aged 6-13 years in Primary schools

Wasting, a measure of acute malnutrition was estimated at 6% in 2009 in Kenya, but there are huge regional variations such as in Arid and Semi-Arid Lands (ASAL), where food insecurity and drought have affected the population (UNICEF, 2012). According to other studies, effect of improved water supply, on nutritional status of household members was positive (Masset et al., 2012). The same situation was witnessed in Yatta District of pupils with and without improved waters supply where according to the findings, of pupils aged 6-10 years with and without improved water supply, a mean of 23.1kg and 20.5kg weight respectively were determined. There was therefore a significant difference ($P < 0.05$) between pupils aged 6-10 years with and without improved water supply with respect to weight. Of pupils with and without improved water supply, a mean height of 124.0 cm and 112.5cm respectively were determined. Comparing indicators therefore pupils with improved water supply were slightly taller than those without improved water supply. There was a significant difference ($P < 0.05$) between pupils with improved water supply and those without improved water supply with respect to height.

5.5 Effect of improved water supply on Illness (morbidity) of the pupils in Yatta Sub County

As per other studies, the environments in which children live strongly influence the learning of children (Kim et al., 2013). This study is a confirmation of the previous studies where pupils with improved water supply were less (41.0%) sick compared to (46.5%) those who had no improved water supply. The impact of improved water, sanitation, and hygiene (WASH) access on mitigating illness is well documented, although impact of school-based WASH on school-aged children has not been rigorously explored (Freeman et al., 2013).

Globally, nearly a billion people still lack access to improved sources of drinking water, and about 2.5 billion lack improved sanitation (UNICEF & WHO 2013).

Unimproved water and sanitation are major causes of diarrhea, which globally accounts for approximately 1.4 million child deaths each year. The majority of these deaths occur in sub-Saharan Africa where nearly half the population lacks access to improved water and sanitation (UNICEF& WHO, 2012). Although malnutrition levels could therefore largely be attributed to lack of access to adequate nutrition, factors such as poor hygiene practices and disease, occasioned limited access to adequate water supply also contributes to high malnutrition levels and other diseases. In another study, much of the stunting in India was associated with poor sanitation, perhaps a proxy for a pathogenic environment (Spears, 2013).The same was witnessed in another study where the program was able to achieve improvements to both WASH and nutrition coverage, and it reduced stunting., over the three years (Smith et al., 2013).

This study therefore, confirms findings of the above studies stated above. For instance Of pupils with and without improved water supply, 41.0% and 46.5% respectively were ill. Fewer pupils therefore of pupils with improved water supply were ill than pupils without improved water supply. There was a significant difference ($P < 0.05$) between pupils with improved water supply and those without with respect to pupils' morbidity rates in Yatta Sub County.

5.6 Relationships between variables

Independent t-test showed that there was a statistically significant difference ($p < 0.05$) between pupils in schools with improved water supply with those without improved water supply in respect to dietary intake. There was also a significant difference (P <

0.05) between pupils in schools with improved water supply and those without improved water supply with respect to Body Mass Index (BMI) of pupils.

The nutritional status and dietary intake of pupils aged 6-13 years , in Yatta Sub County, were affected by limited improved water supply. This the same with other studies where Scarcity of water often has its roots in water shortage, and it is in the arid and semiarid regions affected by droughts and wide climate variability, combined with population growth and economic development, that the problems of water scarcity are most acute (FAO, 2013).

5.7 Limitation of the study

The results of this study should, however, be considered in light of the following limitations, that though every effort was exerted in order to ensure the representative of the sample, a comparison of the study sample distribution across the schools in Yatta Sub County population for the same age group showed a few discrepancies. Food consumption frequency may not be representative of dietary intakes at the individual level given that some pupils and parents may not have had the capacity to remember how frequently the pupils consumed some specific type of foods (Livingstone & Robson, 2000). A limitation was considered when interpreting the data presented. Limitation to consider was related to the method used for recording dietary intake for children younger than 12 years. Despite the primary caretaker /parents being responsible to record the dietary intake of the child, it should be considered that a parent might have found it difficult to accurately estimate dietary intake consumed at school. Future research should, therefore, focus on demonstrating the health impact of a certain level of dietary intake, in order to progress towards a reference value based on scientific evidence and not only on observed intakes.

CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND FURTHER RESEARCH

6.1 Conclusion

Pupils with and without improved water supply had no significant difference with respect to the parents Demographic and Socio-economic characteristics. It can therefore be concluded that improved water supply had no effect on Demographic and Socio-economic characteristics of pupils' parents.

More pupils with improved water supply than those without improved water supply consumed carbohydrates. Same applied to the intake of iron where more pupils with improved water supply, had an intake of iron than the those without improved water supply. Most pupils had three meals per day and the main staple food was maize and beans (*Isyo*). It can therefore be concluded that improved water supply had an effect on dietary intake and food consumption practices.

Most of the pupils either with or without improved water supply, consumed cereals and pulses regularly. There was no significant difference between pupils who had improved water supply and those who never had with respect to consumption of cereals and pulses. More pupils with improved water supply consumed fruits than those without improved water supply. More pupils with improved water supply consumed main food more frequently that those without improved water supply. Improved water supply had an effect on food consumption frequency.

There was no significant difference between pupils with and without improved water supply with respect to the BMI mean of male and female pupils aged 11-13 years. Of pupils aged 6-10 years with and without improved water supply, the mean weight and height of the ones with improved water supply was slightly higher than the ones without improved water supply. It can therefore be concluded that improved water supply had an effect on nutritional status of pupils aged 6-13 years. Fewer pupils with improved water supply were ill compared to the one without improved water supply. It can therefore be concluded that improved water supply had a positive effect on pupils health.

6.2 Recommendations

There is need for government to address other factors along with water supply including, poverty eradication and improved farming methods. In addition, the government should improve water supply with respect to domestic and irrigation to facilitate crops production in order to curb inadequate dietary intake hence alleviation of malnutrition of school pupils.

There is need for the Ministry of Education in collaboration with the Ministry of Agriculture and the Government of Kenya to facilitate parents /caretakers who are unable to access adequate food, with adequate nutritious food to feed pupils. This will address food insecurity, ensuring that food at household level is always available, adequate, accessible and affordable. This is a long-term measure to improve food intake and curb malnutrition of school going children.

There is need for the Government through the Ministry of Health in collaboration with Ministry of Education to encourage frequent assessment of food consumption practices and nutritional status of pupils countrywide. This will facilitate the identification of nutritional disorders and therefore put in place an intervention to alleviate malnutrition of school pupils.

There is need for the relevant Kenyan Government Ministries and NGOs to provide adequate water supply to enhance hygiene and sanitations. This practice will alleviate increased morbidity rates, that have a negative impact on the nutritional status of pupils aged 6-13 years in Yatta Sub County.

6.3 Suggestions for further research

The following are suggestions for further research

1. There is need for an improved water supply (borehole, dam and others) based intervention study to determine the role played by improved water supply in the management of, dietary intake and nutritional status of the pupils aged 6-13 years day primary schools in Yatta Sub County.

2. There is need for effect of improved water supply on food production and its impacts on dietary intake and nutritional status to be determined.

3.There is need for food security at household level and food market prices and their influence on dietary intake and nutritional status of public primary school pupils determined.

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APPENDICES

Appendix 1: Letter of introduction

Dear respondent,

I, Beatrice Simuli Musee, a postgraduate student, Faculty of Agriculture Jomo Kenyatta University of Agriculture and Technology requests you to participate in my research work.

The topic of this research is determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of Pupils aged 6-13 years , in public mixed day primary schools in Yatta Sub County, Machakos County Kenya. The purpose of the study is to obtain information on effect of improved water supply on dietary intake, nutrition status and morbidity rates of school pupils aged 6-13 years with and without improved water supply. The information collected will be treated as confidential and will only be used for the purpose of the study.

Please accord the necessary assistance.

Yours sincerely,

Beatrice Simuli Musee.
P.O. Box 4264-01002
Thika
Tel: 0723238189.

Please indicate if you will participate in the research by ticking at ´Yes` if you will and at ´No` if you will not.

YES ( ) NO ( ) **Signature----------------------------Date---------------------**

Appendix 2: Informed consent

Dear respondent

This to request for your participation in the study by responding to the questions in the questionnaire/ interview guide. Your participation is purely voluntary and you are free to stop the participation at any stage of the interview. There are no monetary gains in the study. The information given will be held in confidence. The topic of this research is determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of Pupils aged 6-13 years , in public mixed day primary schools in Yatta Sub County, Machakos County. The purpose of the study is to obtain information on effect of improved water supply on dietary intake, nutrition status and morbidity rates of school pupils aged 6-13 years with and without improved water supply.

Certificate of Assent

I understand the topic of this research is determinants of improved water supply and their influence on dietary intake, nutritional status and morbidity rates of Pupils aged 6-13 years , in public mixed day primary schools in Yatta Sub County, Machakos County Kenya. I understand that information will be obtained from me in regards to the effect of improved water supply on dietary intake, nutrition status and morbidity rates.

I have read this information, (or had the information read to me) I have had my questions answered and know that I can ask questions later if I have them.

I agree to take part in the research

OR

I do not wish to take part in the research and I have not signed the assent below.____________(initialed by child/minor)

Only if child assents:

Print name of child ____________________

Signature of child: _____________________

Date:_________________

day/month/year

I have witnessed the accurate reading of the assent form to the child, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness (a parent /teacher)_________________

Signature of witness ______________________

Date ________________________

Day/month/year

I have accurately read or witnessed the accurate reading of the assent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given assent freely.

Print name of researcher_________________

Signature of researcher___________________

Date__________________

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the child understands that the following will be done:

1.Child / parents will be interviewed

2.Anthropometric measurements will be carried out

3.Food samples will be collected for laboratory analysis

4. Observation will be carried out to determine the status of hygiene and sanitation in the pupil's environment.

I confirm that the child was given an opportunity to ask questions about the study, and all the questions asked by him/her have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily**.**

A copy of this assent form has been provided to the participant.

Print Name of Researcher/person taking the assent________________________

Signature of Researcher /person taking the assent ________________________

Date ___________________________

Day/month/year

Copy provided to the participant ________(initialed by researcher/assistant)

Parent/Guardian has signed an informed consent ___Yes ___No _____(initialed by researcher/assistant)

Appendix 3: Questionnaire

Determinants of improved water supply and their influence on dietary intake and nutritional status of pupils aged 6 -13 years in mixed day primary schools in Yatta Yatta Sub County Kenya

Section a:pupils demography and social economic factors.

Respondent: Pupil /parent

Questionnaire no____

School____

Division____-

Date of interview____

1. Please tell me your age, religion, tribe and parents' education level, occupation and marital status? (To be confirmed from parent/caretaker)

Use codes below to fill the gaps below.

Sex_______ Mothers: Education level____ Occupation_____ Marital status________

Age_______ Fathers: Education_______ Occupation_____ Marital status________

Religion_____

Household total population_______.

Codes:

Religions: I – Protestant II– Catholic – III Islam IV-None

Education level: 1-None 2-Primary 3- Secondary 4- college 5-University

Sex (Gender): F-Female M-Male

Marital status: 1-Married 2-Single parent 3-Widowed 4-Divorced/Separated.

Section b. Dietary intake and water supply

1. Determination of dietary intake of pupils

Respondent: parents/caretakers

(i) What regular staple food does your household consumes?

	Crop type	1,.Yes 2,No	Three most important crops(in rank order)
1	Maize		
2	Pulses (Beans ,peas)		
3	Rice		
4	Wheat		
5	Sorghum		
6	Finger millet		
7	Irish potatoes		
8	Sweet potatoes		
9	Cassava		
10	Fruits		

Focus Group Discussion (FGD) guide

(iii) Do you meet all food all year round food requirements of your household members from own production?---

a-Yes b-No

(iv) If you are not self-sufficient, for how many months do you produce to cover the food to bridge the deficiency? ---

(v) Do you or any of your household members engage in nonfarm activities? -------------

a—Yes b—No

(v) If Yes from above does the income you earn from non-farm activities enable you to buy food to bridge the deficiency?---

a-Yes b-No

(vi) According to your own Self –: assessment is your household:**-----------------------**

a. Dietary intake adequate c.Varies from one year to another e. Do not know

b. Dietary intake inadequate d.Varies from one season to another

(vii) if the answer for the above question is that dietary intake inadequate, What do you think are the main reasons for the inadequacy?

	Reasons for inadequate dietary	1-Yes 2-No
1	Inability to produce insufficient grain and to rear livestock	
2	Inability to rear sufficient amount of livestock	
3	Meagre income from non-farm activities	
4	Instability owing to frequents changes in rural policies	
5	Failure to properly utilize own production and other earnings	

(vii) What have been the five main constraints to expanding your crop production, as well as to keeping sufficient amount of stock in order to become self-sufficient in food all year round?

	Main hindrances to crop production		**Major constraints to livestock rearing**
1		**1**	
2		**2**	
3		**3**	
4		**4**	
5		**5**	

(viii) What -are the three principal reasons for lack of sufficient and viable income from non-farm activities to have adequate dietary intake at household level?

a.**---**

b.**---**

2. 24-Hour Dietary Recall

Respondent: pupil/ Parents/ care takers

i. Starting from morning to evening yesterday, please name all the foods and drinks that you consumed in the past 24 hours.
ii. What household equipment do you use to measure your ingredients?
iii. what ingredients were used during food preparation and how much of each was used?
iv. What was the volume of each dish you were served? (To confirm with the parent/caretaker).
How much food remained? (To be measured)

24-Hour Dietary Recall Table

							Official Use
Time/Meal	Type of the dish	Ingredients in the dish	H/h measure	Amt in Grams	Volume 0f dish cooked	Volume taken by child	Amt taken by the child in grams
Breakfast							
Mid-morning snack							
Lunch							
Mid-afternoon snack							
Supper							
After supper snack							

Section c. Food consumption practices

1. **Food frequency**
   Respondent: Pupils/parent/care-taker/ cooks
   Use the table below to answer the following questions

(i)What is the frequency of consumption of the following foodstuff?

Food frequency Table

Food item	Frequency per day	Frequency per week	Frequency per month	Never after a long time.
Carbohydrates				
Maize				
Chapati				
Rice				
Bread				
Porridge				
Irish potatoes				
Proteins:				
Beans				
Milk				
Eggs				
Fish				
Green grams				
Beef				
Chicken				
Vegetables and fruits				
Sukuma wiki				
Carrots				
Cabbages				
Spinach				
Mangoes				
Avocadoes				
Oranges				
Paw paws				

Use appropriate codes above to fill the table:

Codes; per day 1-6per week 1-7 per month 1-30 0- never after a long tim**e**

2. Determination of proximate food composition of each food sample that pupils are fed on Experiment

a. collect one cup (100g) of each of the food samples that pupils were being fed on

b. Determine the proximate percentage of protein, moisture, fat and carbohydrates and ash

c. Determine the relationship between pupils' proximate percentage in food samples taken by pupils and improved water supply.

Food Samples	%moisture		% ash		% fat		%protein		%carbohydrate	
	W	NW	W	NW	W	NW	W	NW	W	NW

3. Determination of food consumption practices in households with and without improved water supply Focus group Discussion guide

Household food insecurity

(i) Determine the food security status of households in Yatta Sub County

S/NO	Characteristics		
1.	None respondent	W%	NW%
2.	Food adequate		
3.	Food inadequate		
4.	None respondent		

W-With improved water supply NW-No improved water supply

ii) Do you think lack of access to sufficient water adversely affects household food shortage?-----------

	Response	1-Agree 2--Disagree			
		W	NW W		NW
1	Vulnerability to drought and erratic rainfall distribution				
2	Low agricultural productivity and production				
3	Taking too much time and energy in fetching water				
4	Induced conflict over water use				
5	Affecting health of household members and food utilization				

W-With water NW-No Water

(iii) If the above answer is Yes in what way?

(iv) If the answer is no for number (ii) then what do you think are the determinant factors for your household food supply

a.--

b.--

c.--

4. Effect of Improved Water supply on food consumption Practices

(ii) How do you compare the livelihood and food security of your school / household during pre- and post- borehole? Water harvesting tanks, intervention?

a. Improved following intervention.
b. Deteriorated following intervention.
c. No changes recognized.

(iii) If the response in the above case is improved since intervention, in which way?

S/NO	Improvement in terms of	1-Yes 2-No			
		W		NW	
1	Diversified sources of income				
2	Increased income in absolute terms				
3	Allowed agricultural intensification through irrigation				
4	Improved health for pupils/ family members				
5	Improved livestock productivity				
6	Others				

W-With water NW- No Water

(iv) If the response to the above is deteriorated, what are the explanations?

a.--

b.--

c.--

d.--

(v) What do you suggest to be integrated with water sector development interventions so as to bring significant improvement in the living standard and dietary intake of your household.

4.Household Food Insecurity Access Scale (HFIAS) Measurement Tool

No	Question	Response Options	CODE
1.	In the past four weeks, did you worry that your household would not have enough food**?**	**0 = No (skip to Q2)** **1=Yes**	**.I___I**
1a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 1.a How often did this happen? 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks	**I___I**
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Ye	**_** **__I**
2a	How often did this happen?	Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**….I___I**
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources**?**	= No (skip to Q4) 1 = Yes	**___I**
3a	How often did this happen?	1 = Rarely (once or twice in the past four weeks)	….I___I

		4.a How often did this happen? 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
4.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	**….I___I**
4a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**.I___**
5	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food	0 = No (questionnaire is finished) 1 = Y	**.I___I**
6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	**.I___I**
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	**.I___I**
7a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the	**….I___I**

		past four weeks) 3 = Often (more than ten times in the past four weeks	
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q) 1 = Yes	**.|___|**
8a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks	**.|___|**
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	**.|___|**
9a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**.|___|**

ii. How do you cope with problem of food shortage?____________________________

	Coping strategy	1-Yes 2-No				Use strategy when food shortage is: (code below)
	critical	W	NW	W	NW	
1	Livestock dispersal or destocking					
2	Changing cropping patterns					
3	Migration to nearby towns for wage labour.					
4	Consuming famine period or less preferred foods					
5.	Borrow grains or cash from relatives					
6.	Borrow grain or cash from money lenders					
7.	Migrate to other rural areas for wage labour.					
	Non Critical					
1.	Sell off small animals					
2	Firewood and charcoal selling					
3.	Rely on relief grains					
4.	Sell off farm oxen					
5.	Lease out land					
6.	Sell off land					
7.	Distress migration					

W-With water NW- No water

1. Less severe 2.Moderately severe 3. Severe

Section d. Determination of nutritional status of pupils

1. Anthropometrics measurements

(i) . What are the pupils' weight, height and mid-upper arm circumference?

1st weight reading__________________ kg

2nd weight reading:________________________kg

Average weight: ---kg.

(ii) Age__________________________________Years

1st height reading_____________________cm

2nd weight reading:_____________________________Kg

Average weight _________________________________kg

Mid-Upper Arm Circumference (MUAC) ______________________cm

Nutritional status of pupils aged 6-13 years in primary schools with and without improved water supply.

Characteristic	W	NW
Weights (kg)		
Heights (cm)		
BMI (kg/m 2)		

W- With improved water supply NW-No improved water supply

Section e: Morbidity status of pupils in yatta sub county Key informants guide

Respondent: Parental care takers, cooks

1. Water and Sanitation

Observation checklist

Instructions: Answer the following questions by using appropriate codes to fill the table below.

i. Does the school access borehole/harvested water/ dams?
ii. What is the school source of water ?
    Borehole/dam/ water tanks/ wells/ piped water (tick what is applicable)
iii. If so what does the school use the water for?
iv. Does the school have tapped water for pupils washing hands after visiting the toilet?
v. what is the wall of the classes made of?
vi. what is the roof of classes made of?
vii. what is the floor made of?
viii. How many toilets/pit latrines does the school have?
ix. Does the school carry out regular cleanliness?
x. what was the volume of each dish you were served? (To confirm with the parent/caretaker).
xi. How much food remained? (To be measured in water measure?
xii. How is food stored?
    Shelves/Refrigerator/Deep freezer/sacks/plastic tins
xiii. How is rubbish disposed?
xiv. Are there open drainage in the school?
xv. what is the condition of school in terms of infrastructure ?

xvi. what is the condition of the walls floor, roof?

xvii. Do pupils wash hands after visiting the toilet? if so do they use soap?

xviii. Are pupils provided with toilet rolls?

xix. Are there drinking fountain buckets and cups in class?

Observation Check list table: Facilities, Structures and sanitation

Facilities, Structures and sanitation Classrooms and toilets	N=200 (%) W	N=200 (%) NW	P-Value
Construction materials			
Makuti			
Cement			
Earth (floor)			
Stone/Bricks, Blocks (Wall)			
Iron Sheets (roof)			
Timber (wall)			
Condition of Walls, roofs, floor			
Dilapidated			
Leaking roofs			
Dirty walls			
Clean walls			
Walls with cracks			
Strong roofs and walls			
Spacious classrooms			
Congested classrooms			
Food service area available			
Food service area not available			
Playing ground and environment Field			
Too long bushes			
Moderately long bushes			
short			
Ventilation			
Adequate			
Not adequate			
Latrine/toilet			
Present			
Absent			
Adequate			
Inadequate			
Far from classes			
Moderately far from classrooms			
Near classrooms			
Safety measures			
Fire extinguisher available			
Fire extinguisher not available			
Fire alarm			
No fire alarm			
Sand in buckets			
No sand in buckets			

W- With improved water supply NW-No improved water supply

Observation Check list.

Codes: construction materials;

1 – Earth2 – Cement 3 – Iron Sheets **4** – Stone/Bricks, Blocks 5– Makuti **6**-Timber

Hygiene and health living for pupils aged 6-13 years with and without improved water supply in Yatta Sub County

Hygiene and sanitation	N=200 (%) W	N=200 (%) NW	P-Value
Garbage disposal			
Pit			
Burning			
Dust bin and waste paper baskets available			
Dust bins ad waste paper baskets not available			
Garbage collection services available			
Garbage collection services not available			
Toilet rolls available			
Toilet rolls not available			
Regular cleaning of classrooms and toilets			
No regular cleaning of classrooms and toilets			
Water sources			
Piped water			
wells			
Dams			
Boreholes			
Water tanks			
Soap available for washing hands			
No soap available for washing hands			
Washing hands basin and stand available			
No washing hands basin and stand available			
Drinking fountain buckets and cups in class			
No drinking fountain buckets and cups in class			
Open drainages			
No open drainages			
Method of food storage			
shelves			
Refrigerator			
Deep freezer			
sacks			
Plastic tins			

W-With improved water supply NW-No improved water supply

Rubbish disposal:

M-Taken by municipal council   L-compound G-Thrown in school compound pit

Source of water:

T-tapW-well B-Borehole   R-RainV-Pond

Drainage:

A-Clean   C-Not clean X-Blocked Bushy- V

Instrument 3

Respondent: Head teacher questionnaire

28. Tell me the total number of pupils in the school______________

29. What is the total number of classes in the school? ____________

30. Tell me the total number of pupils aged 6-13 years__________

31. What is the total population of each sex?

Females________________ Males__________________________

32. Do you offer any meals to the pupils___________________ (Yes –1, No- 2, fill in the Appropriate answer).

2. Morbidity status of pupils

Respondent: pupils/parents /care takers

1. Have you been sick in the last one-month? _____ Yes- 1 No – 2

2. Which of the following illnesses have you suffered from and for how long were sick?

	Diseases	**Tick illness experienced**	**Duration of illness (Days)**	
			NW	**W**
1.	**Fever (Indicator of malaria,typhoid)**			
2.	**Continuous coughing (indicators of Tuberculosis asthma etc)**			
3.	**Difficult breathing (indicators of Pneumonia etc)**			
4.	**Diarrhea**			
5.	**Colds**			
6.	**Others**			

W- With improved water supply   NW-No improved water supply

3.What was the Proportion of illness in the Sub County-?

S/NO	**Characteristic**	**N**	
1.	**Illness**	**W (%)**	**NW(%)**
2.	**Sick**		
3.	**Not sick**		

W- With improved water supply   NW-No improved water supply

Appendix 4: Approximate composition of raw food in 100g edible portion of food

S/№	Food	%EP	Water (g)	Average Kcal	Protein (g)	Fat (g)	Sugar (g)	Starch (g)	Fibre (g)	Iron (mg	Vit.A RE	Folate (mg)	Vit. C (mg
1.	Cereals:												
2.	Maize white (whole grain)	100	12	345	10.0	4.5	-	67	1.9	2.5	0	-	0
3.	Rice (polished)	100	12	335	7.0	0.5	0	80	0.1	1.0	0	29	0
4.	Wheat flour (white bread)	100	37	240	7.7	2.0	4.0	4.7	3.0	1.7	0	28	0
5.	Brown bread	100	38	235	7.7	2.0	3.0	47	5.0	2.2	0	37	0
6.	Chapatti (made with fat)	100	29	328	8.1	12.8	-	48	3.7	2.3	0	15	0
7.	Potato (Irish)	86	78	75	1.7	0.1	1.0	17	0.6	1.1	3	14	21
8.	Starch roots:												
9.	Yam fresh	84	69	110	1.9	0.2	0.6	27	0.8	0.8	4	-	7
10.	Leguminous:												
11.	Beans (kidney shaped)	100	12	320	22.0	1.5	1.0	5.6	4.4	8.2	3	180	1
12.	Pigeon peas	100	16	322	20.0	1.3	7.0	51	7.3	5.0	9	100	0
13.	Vegetables:												
14.	Carrots	74	89	35	0.9	0.1	8.2	0	1.4	0.7	1088	8	8
15.	Cabbage	85	79	19	1.4	0.2	-	3	0.7	0.7	0.4	75	39
16.	Tomato	96	94	22	1.0	0.2	3.0	1	0.6	0.6	74	28	26

17.	Avocado	50	80	120	1.4	11.0	3.0	1	1.8	1.4	88	22	18
18.	Banana	63	77	82	1.5	0.1	7.0	3	0.9	1.4	20	19	8
19.	Guava	81	82	46	1.1	0.4	5	-	5.3	1.3	48	7	325
	Lemon Lime	59	90	40	0.6	0.8	5.0	3	0.7	0.7	2	1.0	4.5
S/№	Fruits	%EP	Water (g)	Average Kcal	Protein (g)	Fat (g)	Sugar (g)	Starch (g)	Fibre (g)	Iron (mg	Vit.A RC	Folate (mg)	Vit. C (mg
1.	Mango	72	83	60	0.6	0.2	13.0	2	0.9	1.2	400	7	42
2.	Orange	752	88	44	0.6	0.4	9.0	1	0.6	0.1	122	37	46
3.	Tangerine:												
4.	Pawpaw	74	91	30	0.4	0.1	6.4	1	0.9	0.6	200	1	52
5.	Pineapples	55	87	48	0.4	0.1	12.0	0	0.5	0.4	15	11	34
6.	Watermelon	50	94	22	0.5	0.1	5.1	0	0.4	0.3	42	3	8
7.	Sugars:												
8.	Sugar	100	0	400	0	0	100	0	0	0	0	0	0
9.	Honey	100	23	286	0.4	0	76	0	0	0.4	0	0	0
10.	Milk:												
11.	Cow milk (whole fresh)	100	87	66	3.5	3.7	4.9	0	0	0.05	52	5	1
12.	Goat milk	100	84	84	3.4	4.9	7.0	0	0	0.1	25	-	1

Source: Nutrition guide by Onila Salins 2nd Edition (2004).

Appendix 5: Approximate composition of cooked foods in 100g edible portion of food

	Water (g)	Energy (Kcal)	Protein (g)	Iron (Mg)	Vit A (RE)	Vit C (Mg)
Maize stiff porridge	75	100	2.3	0.3	0	0
Rice polished boiled	70	123	2.8	0.3	0	0
Plantain	70	111	0.1	0.9	110	12
Potato boiled	78	75	1.7	1.7	-	16
Potato fried/ Chips	47	250-562	3.8	0.9	0	15
Beans boiled	65	128	8.8	3.3	-	0
Cabbage boiled	93	23	1.6	-	40	40
Chicken boiled (% E P=67	61	203	260	1.5	110	0
Fish steamed % E P 52	74	118	20	1.8	-	0

Source: Nutrition guide by Onila Salins 2nd Edition (2004).

Gross chemical composition of different types of maize (%)

Maize type	Moisture	Ash	Protein	Crude fibre	Ether extract	Carbohydrate
Salpor	12.2	1.2	5.8	0.8	4.1	75.9
Crystalline	10.5	1.7	10.3	2.2	5.0	70.3
Floury	9.6	1.7	10.7	2.2	5.4	70.4
Starchy	11.2	2.9	9.1	1.8	2 2	72 8
Sweet	9 5	1 5	12.9	2.9	3.9	69.3
Pop	10.4	1.7	13.7	2.5	5.7	66.0
Black	12.3	1.2	5.2	1.0	4.4	75.9

Source: Cortez and Wild-Altamirano, 1972.

Appendix 6: Daily requirement and 2002 Dietary References for 10-11 years

Nutrients	Male	Female
Reference BMI	17.2	17.4
Reference ht (cm)	141.0	143.0
Reference wt(kg)	34.0	35.4
Energy (Kcal)	2170.0	1925.0
Carbohydrates	130.0	130.0
Total fibre	31.0	26.0
Protein (g/d)	54.0	57.0
Fat(g)	60.0	53.0
Iron(mg)	12.0	11.0
Iodine (mg)	150.0	150.0
Vitamins A(RE)	500.0	500.0
Thiamine (mg)	1.0	0.9
Riboflavin (mg)	1.6	1.4
Niacin (mg)	17.2	15.5
Folate (µg)	110.0	120.0
Vitamin C (mg)	20.0	20.0
Linolenic acid g/d	12.0	10.0

Source: Nutrition for Developing countries by Felicity Savage King and Ann Burgess Second edition 1992.

Appendix 7: Conversion list

FOOD	MEASURE	MASS (weight)
Rice cooked Loosely packed	125 mls (1/2cup)	105g
Cooked rice Tightly packed	75(1/3cup)	70g
Slice of bread	1 slice	75g
Beans dried cooked	125mls(½c)	80g
Potatoes whole 13cm, 5cm Diameter	1/2	95g
Yams, sweet potatoes 13cm, 5cm diameter	1/2	75g
Doughnuts (plain) 7cm, 23cm diameter	1	30g
Mango, raw without skin	1/3	65g
Oranges with rind	1 small	130
Papaya with skin, raw	¼ medium	150g
Pineapple raw sliced	1slice, 8cm diameter 2cm thick	75g
Tomato based mixed vegetables	250ml	255g
Carrots diced	125ml(1/2c)	75g
Pumpkin mashed	125ml(1/2c)	45g
Avocado	1/8	30g
Bacon	5mls	5g
Margarine	5mls(1 tsp)	5g

Source: Nutrition guide by Onila Salins 2nd Edition (2004).

Appendix 8: Food intake by children aged 6-13

Food in grams	Male	Female
Cereals	420	380
Pulses	45	45
Leafy vegetables	50	50
Roots and tubers	50	50
Milk	30	30
Oil and fat	250	250
Sugar	22	22
Fruits	45	45
meat	60	60

Appendix 9:Twenty-four hour dietary recall measurement tools

Equivalents

Household measures	Metric system
1 teaspoon full	4 millilitre
1 dessert spoonful	8 millilitre
1 tablespoon	15 millilitres
2 tablespoons	30 millilitres
1 glass full	240 millilitres
1 cup	180 millilitres
1 litre	1 kg
10 ounces	30g
1 pint	473g
1 quarts	946g

Source*:* United States Dept. of Agriculture (USDA).

Appendix 10: Interpretation of cut-offs of children aged 5-19 years

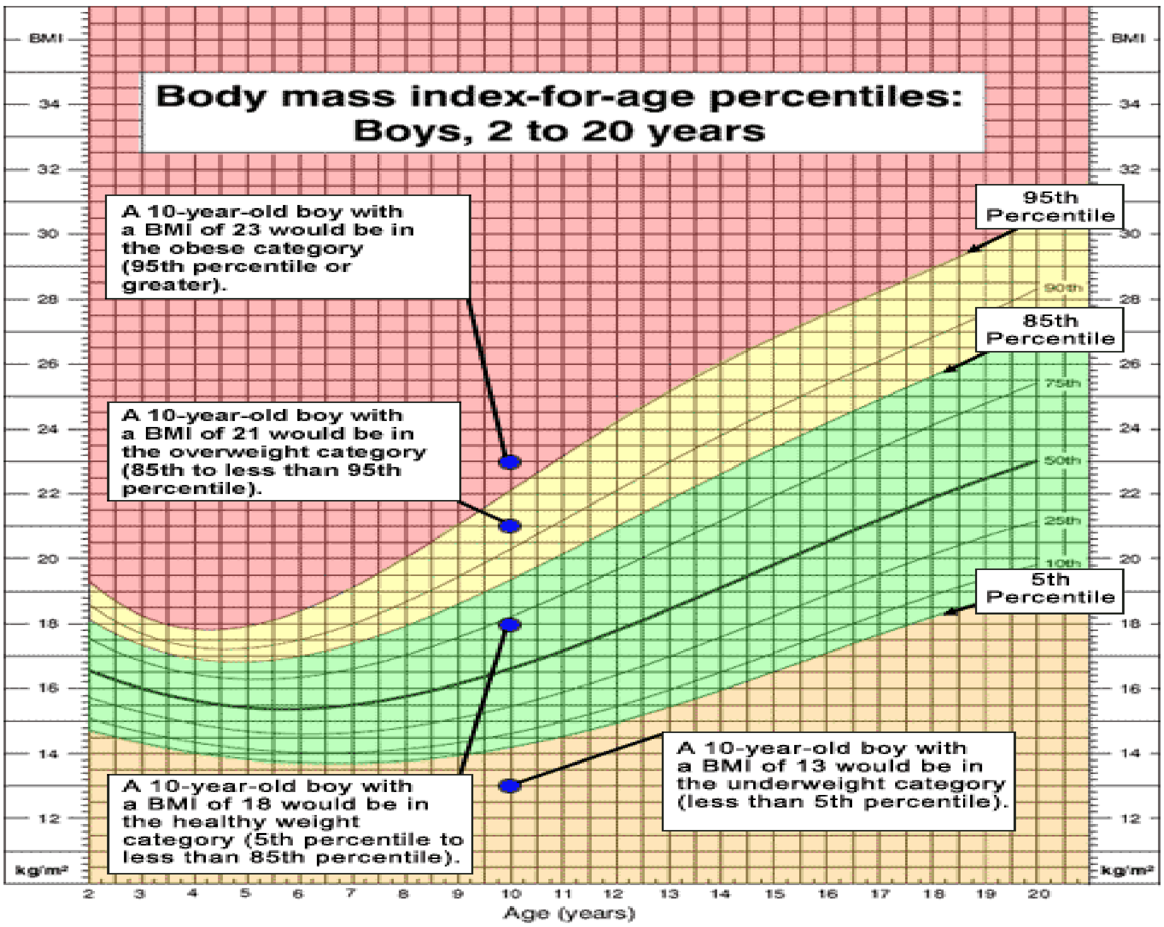
Weight Status Category	Percentile Range
Underweight	Less than the 5^{th} percentile
Normal or Healthy Weight	5th percentile to less than the 85^{th} percentile
Overweight	85th to less than the 95^{th} percentile
Obese	Equal to or greater than the 95^{th} percentile

Kids who measure at the 85th to 94th percentiles are considered overweight, because of excess body fat or high lean body mass. A child whose BMI is between the 5th percentile to 85th percentile is in the healthy weight range. A child with a BMI below the 5th percentile is considered underweight.

To calculate a child's BMI, the following procedure has to be followed:

1) measure his weight (pounds
2) measure his height (inches
3) calculate his BMI by dividing your child's weight by his height squared and multiplying the total by a conversion factor of 703

The following is an example of how sample BMI numbers would be interpreted for a 10-year- boy:

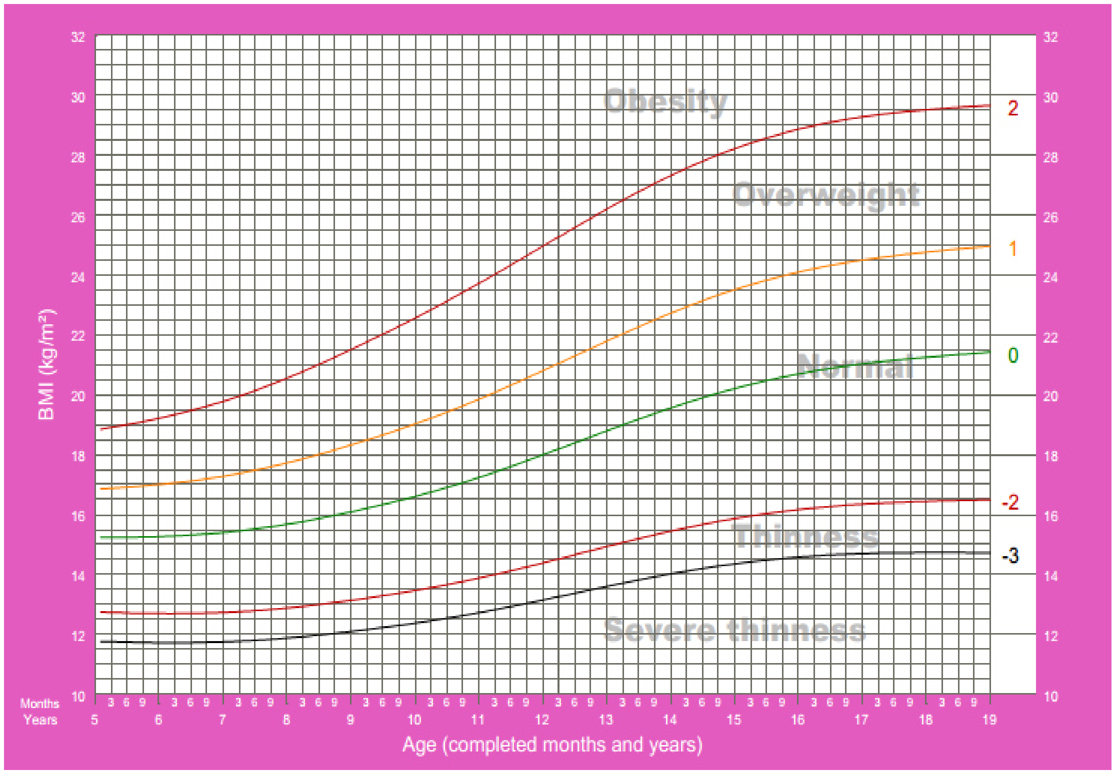


Source:The CDC BMI-for-age growth charts are available at: CDC Growth Charts: United States.Access the CDC Growth Charts here: http://www.cdc.gov/growthcharts/clinical_charts.htm

BMI-for-age GIRLS

5 to 19 years (z-scores)

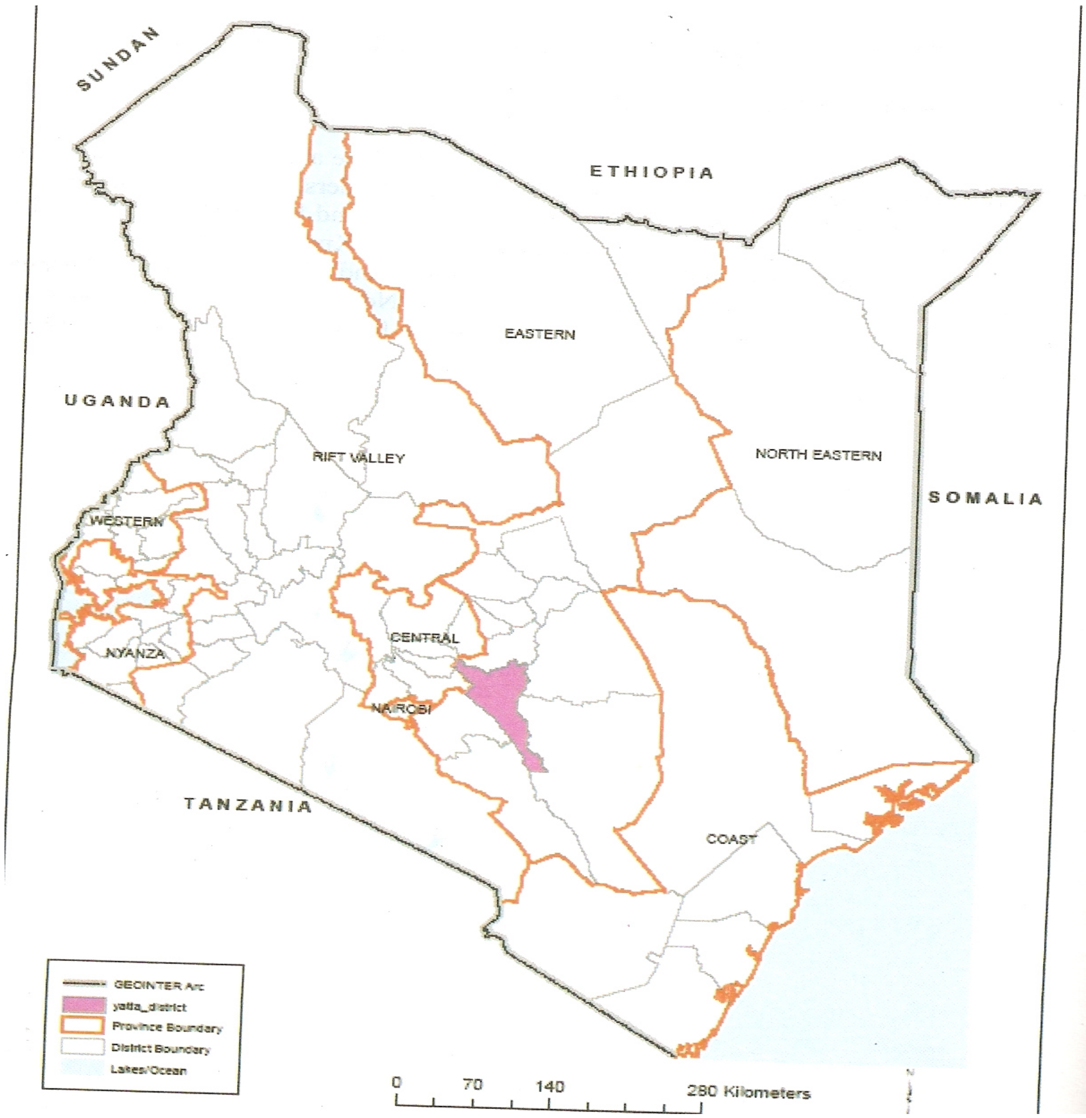
World Health Organization



2007 WHO Reference

Appendix 11: Map of Yatta Sub County

Appendix 12: The map of Kenya



Appendix 13: Data collection schedule

SCHOOL	DIVISION	DATE
KISAAN (NO IMPROVED WATER SUPPLY) KATANGI (HAS BOREHOLE)	KATANGI KATANGI	28/02/2012 07/03/2012
MUKALALA (NO IMPROVED WATER SUPPLY) KITHIMANI HGM (HAS BOREHOLE)	YATTA YATTA	07/03/2012 14/03/2012
NGUUMO (NO IMPROVED WATER SUPPLY) KITHEUNI (HAS BOREHOLE)	IKOMBE IKOMBE	04/04/2012 04/04/2012

Appendix 14: Yatta Sub County pupils' population per division in 2012

DIVISION	Males	Females	Total population
Yatta	9135	13359	22494
Ikombe	6476	6305	12781
Katangi	3429	3241	6670
GRAND TOTAL	19040	22905	41945

Appendix 15: Anthropometric measurement exercise

Appendix 16: Pupils queuing for food in Kithimani HGM (School with improved water supply)

Appendix 17: Determination of protein content using Kjeldahl C.1883

Appendix 18: Household measuring equipments

Appendix 19: Research permit

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THIS IS TO CERTIFY THAT

Prof./Dr./Mr./Mrs./Miss./Institution

Beatrice Simuli Musee

Of (Address) *Jomo Kenyatta Agriculture & Technology P.O BOX 6200, Nairobi*

has been permitted to conduct research in

Location

Yatta District

Eastern Province

TOPIC: Impact of improved water supply on food security and nutritional status of pupils aged 6-13 years in mixed day primary schools in Yatta District Kenya

for a period ending 30th *January* 2014

PAGE 3

PERMIT No. ***NCST/RCD/14/011/1685***

Date of issue *9th January, 2011*

Fee received *KSHS.2,000*

Applicant's Signature

Secretary
National Council for Science & Technology