**Effects of Food-Based Nutrition Education Intervention on Knowledge, Attitudes, Practices and Dietary Behaviours of Primary School Children in Ndhiwa, Homa-Bay County, Kenya**

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# ABSTRACT

Several studies indicate that food-based nutrition education interventions are effective in improving the adoption of recommended nutrition practices among school-age children as indicated by changes in knowledge, attitudes, practices and food consumption. However, there is little evidence of the effectiveness of such interventions in developing countries such as Kenya, where micronutrient malnutrition (MM) remains a significant problem, particularly among school-age children who are rarely targeted by nutrition interventions.

This research used a pre-post quasi-experimental design to assess the effects of a food-based nutrition education intervention on nutrition knowledge, attitudes, practices and food use among grade six children in six primary schools in Ndhiwa, Kenya. A culturally appropriate food-based nutrition education intervention featuring both theoretical and practical components was not available; there was therefore a need to first develop and pilot a program for grade six Kenyan school children. The study objectives were (i) to develop a food-based nutrition education curriculum and questionnaires for evaluation based on the Health Belief Model to assess the outcomes of the intervention; (ii) to evaluate the effectiveness of food-based nutrition education program by comparing children's food-related knowledge, attitudes and practices (KAP) and food consumption prior to and following a six-week nutrition education program. This school- based intervention focused on knowledge, attitudes and recommended food preparation practices that maximize the intake and utilization of food sources of iron, zinc, β carotene and vitamin C which have been identified as lacking in Kenyan children’s diets. Data were collected using in-class questionnaires.

Results indicated that participants in both the intervention and comparison groups were highly knowledgeable on handwashing prior to the intervention, and this remained similar post-intervention p=0.22 and p=0.13, respectively. The intervention group had more positive attitudes regarding handwashing (p=0.01) and practiced more handwashing (p=0.03) than the comparison group. Knowledge scores (p=0.0001), attitudes scores (p=0.0001), barriers scores (p=0.002) and practices scores (p=0.002) related to iron and zinc were significantly higher in the intervention than in the comparison group. Similarly, knowledge scores (p=0.004), attitudes scores (p=0.002) and practices scores (p=0.0001) related to vitamin A and C were also higher in the intervention group than the comparison group. In addition, kitchen gardening knowledge (p=0.01) and attitudes (P=0.01) increased significantly in the intervention group relative to the comparison group, while in contrast, fewer participants in the comparison group perceived kitchen gardening as difficult compared to the intervention group. There were no significant changes in the consumption of foods targeted by the intervention over the study.

This research suggests that the food-based nutrition intervention had a positive effect on nutrition knowledge, attitudes and practices of the school children. There was little impact on children’s food consumption, possibly due to environmental factors beyond this study's scope. This work will inform the development of future curriculum for interventions that aim to improve these outcomes. Future research is needed to investigate the long-term effects of this food-based intervention on nutrition knowledge, attitudes and practices, as well as on the micronutrient status of Kenyan school children.

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# Chapter 1.0: Introduction

Food security is a state where people have access to adequate amounts of safe, nutritious foods for normal growth, development and to lead an active, healthy life (Food and Agricultural Organization, (FAO), 2017; Nkuepo, 2012). A recent food security assessment conducted in Sub Saharan Africa (SSA), North Africa, Asia, and Latin America & the Caribbean showed that SSA has the highest proportion of food insecure people at 35% (Meade & Thome, 2019) Amongst the SSA sub-regions of Central, East, and West Africa, East Africa had the most food-insecure people in 2019 (142 million). Kenya, a country located in East Africa, had 29% of its 47.5 million people being food insecure, and 36% living below one USD$ a day (Food and Agriculture Organization, 2019; Kenya National Bureau of Statistics, (KNBS), 2019; Meade & Thome, 2019). Food security is affected by multiple factors such as climate change, human population growth, water scarcity, political instability, food price fluctuations, diseases, unemployment, inadequate infrastructure, poor production technologies, and, above all, poverty (Nkuepo, 2012; World Food Program, 2018).

The prevalence of micronutrient malnutrition has also been on the rise since it is associated with food insecurity (Food and Agricultural Organization, (FAO), 2017). Micronutrient malnutrition (MM), which refers to the diseases arising from dietary deficiencies of vitamins or minerals, is a problem in many developing countries (Mushaphi et al., 2015; Ochola & Masibo, 2014; Ritchie & Roser, 2019). It has devastating impacts on physical and mental development as well as the ability to cause chronic diseases later in life (Burchi et al., 2011). Addressing MM requires a multifaceted approach since it has myriad causes that include food insecurity, poor maternal and childcare, inadequate dietary diversity and poor health and sanitation status (Blasbalg et al., 2011).

Several strategies have been used in different countries to address MM. In Kenya, these include vitamin and mineral supplementation, food fortification, kitchen gardening, school feeding programs, deworming as well as food, nutrition and sanitation education.

Mineral and vitamin supplementation programs target groups that are considered vulnerable to specific micronutrients deficiencies; for example, vitamin A supplements are recommended for children below five years of age, according to the Government of Kenya (Republic of Kenya (MoH), 2016b). The general population, including children and adolescents, are expected to get these minerals and vitamins through the regular foods they consume, which is challenging given that diets often lack diversity (Kiige, 2004; Ochola & Masibo, 2014). Food fortification is also an ongoing strategy in Kenya that targets the general consumers of staple food commodities like maize flour; however, its effectiveness has been challenged by the difference in lifestyle that distinguishes rural and urban life. Most of the rural population access food directly from their farms; for instance, they produce maize which is locally milled into flour. As a result, their consumption of fortified foods is limited (Faber et al., 2014; Imhoff-Kunsch et al., 2007). Both supplementation and fortification are viewed as less effective since they are top-down approaches that do not involve children or the general population in understanding the food sources of the nutrients supplemented/fortified (Burchi et al., 2011). Promotion of health and sanitation practices also prevents non-food causes of MM such as diarrheal disease due to inadequate access to clean and safe drinking water and parasitic infections, both of which could prevent absorption of nutrients (Okoyo et al., 2016).

Nutrition education in schools is a common strategy that has been applied globally to teach recommended eating habits and to increase awareness of nutrition issues beginning with young children (Mushaphi et al., 2015; Sempele, 2019). Similar to South Africa, (Bello & Pillay, 2019; Oldewage-Theron & Napier, 2011), nutrition education has been part of the science curriculum for primary schools in Kenya (Republic of Kenya (MoE), 2019). Little time is spent on learning nutrition since it is usually incorporated into the existing subjects, and the syllabi are usually overloaded with other non-nutrition topics that are also competing for school time (Oldewage-Theron & Napier, 2011). The Kenya Institute of Curriculum Development has identified various challenges with regards to the original science curriculum, which was nutrient-based rather than food-based and has little practical application of theory (Republic of Kenya (MoE), 2019). As a result, it is currently being phased out in Kenya. The new curriculum called “the competency-based curriculum” provides information regarding which foods and food preparation practices provide the nutrients needed to promote good health and reduce micronutrient malnutrition as well as pragmatic lessons on food production and preparation (Republic of Kenya (MoE), 2018b). The revised curriculum is currently being implemented in grades one to four; children in higher grades, who are more likely to be involved in home food preparation, continue to receive the original curriculum for their grade level (Republic of Kenya (MoE), 2018a). This food-based nutrition education approach is likely to be more effective in achieving sustainable solutions to micronutrient malnutrition (Blasbalg et al., 2011; Hodge et al., 2015; Thompson & Amoroso, 2014), many countries have reported challenges in initiating and sustaining food-based nutrition programs, citing inadequate resources to implement these programs (Thompson & Amoroso, 2014). There are, therefore, very few such programs in developing countries with most being initiatives of non-governmental organizations.

The University of Prince Edward Island, in collaboration with Farmers Helping Farmers, a non-governmental organization, have implemented a food-based nutrition education program among women’s self-help groups in Meru, Kenya. The program included a food-based nutrition curriculum that involved food preparation demonstrations as well as training on key nutrition messages designed to reduce MM. Participation in the program resulted in improvements in the nutrition knowledge, attitudes, practices, and food consumption of the participants (Muthee, 2018). A study that employed a similar strategy with orphans and vulnerable children in South Africa also reported comparable results (Bello & Pillay, 2019). Additionally, similar studies conducted with school-age children in the Netherlands and India have also indicated improvement in nutrition knowledge, attitudes and practices (Leuven et al., 2018; Naghashpour et al., 2014). However, there are few studies that have evaluated the effectiveness of food-based nutrition education on knowledge, attitudes, practices and food consumption of children in primary schools, especially in the rural areas of Kenya. The success of these food-based studies, coupled with the gaps identified in the literature, informed the idea of conducting a similar food-based nutrition education program in schools to assess its effects on school-age children in Kenya.

The study involved the development, implementation, and evaluation of a food-based curriculum to educate primary school children in Ndhiwa, Homa-Bay County, Kenya. Topics Included nutrition-related knowledge, attitudes and practices, kitchen gardening, food preparation skills, recommended food consumption and personal hygiene and handwashing skills.

# Chapter 2.0: Literature Review

## 2.1 Global Food and Nutrition Security

Food security is defined as access to nutritionally adequate, safe, and acceptable foods (Food and Agricultural Organization, (FAO), 2017). It is measured in terms of accessibility, stability, availability, and utilization of food from the household to the global level. There are several contributors to food and nutrition security, including economic, climatic, and political factors. Besides the climatic changes and the cyclic nature of poverty, the state of food and nutrition security in Kenya and other developing countries have also been affected by high vulnerability levels and low adaptation capacities (Nkuepo, 2012; Ogenga et al., 2018). These factors have led to reduced agricultural output and overreliance on humanitarian aid.

Sub-Saharan Africa remains the most affected by food insecurity, with 9 out of 10 poorest countries in Africa found in this region (Zotor & Amuna, 2008). In the year 2015, 36.1% of the 44 million Kenyans lived below the poverty line of one USD (Food and Agriculture Organization, 2019). This reduced slightly to 35.6% and is attributed to the new system of government where the country was subdivided into 47 distinct administrative counties which are interdependent with the national government (World Bank, 2018). Despite the slight improvement associated with the devolution of resources to the grassroots of Kenya, malnutrition rates have remained unacceptably high (Fernandes, T., 2018; Republic of Kenya (MoH), 2020b). Various reports and studies have confirmed that food insecurity, poor health and sanitation conditions, inadequate child-care and feeding practices are the most significant causes of undernutrition (Food and Agricultural Organization, (FAO), 2017; Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016a).

Undernutrition is the continuous inadequate intake of energy and nutrients resulting in poor absorption and poor biological use of nutrients consumed (Republic of Kenya (MoH), 2011). It encompasses both protein-energy malnutrition and micronutrient malnutrition (Ministry of Health 2011; Bhutia, 2014). Undernutrition manifests in various forms across different age groups and is evidenced by underweight (low weight for age), stunting (low height for age), and wasting (low weight for height) (Republic of Kenya (MoH), 2011). Globally, the number of undernourished people has remained stubbornly high for many years (Fernandes, 2018), despite the slight reduction from 854 million to 820 million over the last four years (Food and Agriculture Organization, 2019). Africa has the highest number of people with malnutrition in the world, with stunting levels of 39% and wasting levels of 28% among children below five years of age (UNICEF/WHO/WB, 2021). Among the African regions, the Middle East and East Africa, where Kenya exists, have the highest prevalence, with undernutrition rates of 27% and 31%, respectively (Food and Agriculture Organization, 2019). According to the 2014, Kenya Demographic Health Survey (KDHS) 26% of children under five years are stunted, and 11% are underweight (Kenya National Bureau of Statistics, 2015). This is slightly higher than the rates in Homa-bay County where, 8% and 23% of children under five years of age are underweight and stunted respectively (Kagombe et al., 2016). However, these statistics for children under five years of age are considerably lower than those of school-age children above five years of age. A Nigerian study with school-age children between 7-12 years of age found that 77% and 56% of the school children were stunted and underweight respectively (Onimawo et al., 2010); an indication that undernutrition is widespread among the school-going children in developing countries (Ochola & Masibo, 2014). The high undernutrition rates pose a significant challenge to Kenya's government as they strive to end hunger and poverty. Accordingly, food and nutrition security has become a primary focus in the current Kenyan Government`s development agenda (Kenya National Bureau of Statistics, (KNBS), 2019) and it continues to implement various strategies to ensure that all Kenyans are food secure.

## 2.2 Micronutrient Malnutrition

Micronutrient malnutrition (MM) is a type of malnutrition that results when body cells do not receive an adequate supply of the essential nutrients continuously due to poor diet or poor utilization of foods consumed (Hongo, 2003; Kagombe et al., 2016; Republic of Kenya (MoH), 2011). In many developing countries, the prevalence of micronutrient deficiencies is high among school children, particularly at the critical stages of life when requirements for specific minerals and vitamins are high (Ochola & Masibo, 2014; Republic of Kenya (MoH), 2011). According to the Kenya National Micronutrient survey, 2011, the prevalence of iron deficiency is 9.4%, zinc deficiency is at 80.2%, and vitamin A deficiency (VAD) and Marginal VAD are 3.6% and 34%, respectively, among the school-age children (Republic of Kenya (MoH), 2011). Similarly, a study conducted with Nigerian rural school children found that 83% and 78% had anaemia and iron deficiency respectively (Onimawo et al., 2010). In Homa-Bay County, the mortality of children under five years of age is associated with nutritional deficiencies in terms of protein-energy, zinc, and vitamin A (Kagombe et al., 2016). Numerous reports highlight the same causal factors of micronutrient malnutrition (Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016a; Republic of Kenya (MoH), 2018; Save the Children, 2017). For instance, over-reliance on undiversified staple foods, high disease burden, and poor hygiene and sanitation practices are common causes (Chepkirui, 2019; Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016; Save the Children, 2017; Thompson & Amoroso, 2014).

In low-income countries, Kenya included, diets are typically plant-based, with most people relying on staples such as cereals, grains, and legumes (Muthee, 2018; Republic of Kenya (MoH), 2011; Thompson & Amoroso, 2014). These diets lack essential foods or food groups such as vegetables, fruits, and animal protein which are rich sources of micronutrients. Even with adequate or excessive intake of starchy diets, diets low in these foods put people, especially women and children, at a higher risk of multiple micronutrient deficiencies (Moursi et al., 2008). Unlike protein-energy malnutrition deficiencies, vitamin and mineral deficiency symptoms may take longer to manifest physically and can go without detection (Bhutia, 2014; Kiige, 2004); thus, can lead to severe physical and mental health effects. MM has a cyclic pattern that can lead to long term effects such as low birth weights, poor cognitive development, delayed developmental milestones, high risk of cognitive impairment, mortality, and reduced economic development (Bhutia, 2014; Hongo, 2003; Kiige, 2004; Republic of Kenya (MoH), 2011). MM traces its roots from infancy, where a child is born with acquired MM due to prenatal malnutrition (Republic of Kenya (MoH), 2011). Since almost half of Kenyan women suffer from either one or multiple micronutrient deficiencies (Save the Children, 2017), many infants are born with an already compromised nutrition status, beginning their lives with a marked disadvantage (Save the Children, 2017). Finally, the underutilization of traditional micronutrient-rich vegetables has also contributed to micronutrient malnutrition over time (Hongo, 2003). The naturally growing dark green leafy vegetables are micronutrient dense and inexpensive for low-income people. However, these vegetables are considered as indicators of low status and are, therefore, not regularly consumed (Thompson & Amoroso, 2014). A cross-sectional kitchen gardening study with women in Kajiado, Kenya, found that the Indian spinach (Basela alba), spider plant, cow pea leaves and pumpkin leaves were among the least consumed green leafy vegetables with 75% of the households who grew the Indian spinach using it mainly as live fence (Kiige, 2004). Educational programs to encourage the production and consumption of micronutrient-rich vegetables are thus needed.

## 2.3 Approaches to Mitigate Micronutrient Malnutrition

### 2.3.1 Deworming

Parasite infestation is a significant predictor of undernutrition because parasites increase the demand for nutrients and reduce the body's ability to absorb and utilize nutrients from the foods ingested (Bhutia, 2014; Kenya National Bureau of Statistics, 2015; Okoyo et al., 2016). According to the 2011 Kenya micronutrient survey, the 2014 Kenya Demographic Health Survey (KDHS), studies conducted with school-age children in Burkina Faso and Nigeria, there is a strong association between undernutrition, anaemia, and parasitic infestation (Erismann et al., 2017; Kenya National Bureau of Statistics, 2015; Onimawo et al., 2010; Republic of Kenya (MoH), 2011). Similarly, the 2017-2022 National Food and Nutrition Security Framework highlights that 50% of undernutrition cases in Kenya are linked to intestinal worms and poor water, sanitation, and hygiene (WASH) (Food and Agricultural Organization, (FAO), 2017). A cross-sectional study conducted with schools in Kenya also found that the Homa-Bay region is a hotspot for hookworms (Okoyo et al., 2016).

Deworming is one of the most cost-effective high-impact nutrition interventions used to combat worm infestation problem in many African countries (Masaku et al., 2017; Okoyo et al., 2016; Tabi et al., 2018). In Kenya, deworming is a health and nutrition indicator that is monitored among other health and nutrition indicators (Okoyo et al., 2016; Republic of Kenya (MoH), 2017). Since 2012, school-age children in Kenya periodically receive anti-helminthic medications according to WHO guidelines through the national school deworming program (Okoyo et al., 2016). This school deworming program has been evaluated through a series of surveys which have shown that deworming is effective in reducing soil-transmitted helminths (Okoyo et al., 2016). However, the prevalence of intestinal worm infestation remains high among school children in Kenya due to re-infection (Mulambah & Ruto, 2016; Okoyo et al., 2016). After two rounds of mass deworming drug administration, analysis of school children’s stool samples indicated re-infection rates of ≤ 8 % for each soil-transmitted helminth species, hookworms, ascaris lumbricoides, and trichuris trichiura (Okoyo et al., 2016).

Regular hygiene and sanitation education is also vital in ensuring proper handwashing since it is through hands, that most germs are introduced into the human body (CAWST, 2017; Unicef, 2013). The current science curriculum used in Kenya has highlighted the benefits of general hygiene, both personal and environmental (Republic of Kenya (MoE), 2019). However, a survey conducted with mothers in Ndhiwa, Homa-Bay, Kenya, indicated a gap in the general hygiene and handwashing practices. Latrine coverage (% number of homesteads with functional latrines/toilets) was 63.1%, while handwashing at the four critical times (after visiting the toilet, before eating, before handling food and after cleaning a child’s bottom) was generally low at 14% (Republic of Kenya (MoH), 2016). Similarly, other cross-sectional studies with school children in Ghana and Ethiopia have also shown that the practice of regular handwashing is still a challenge among school-going children; where <50% had good handwashing practices (Dajaan et al., 2018; Eshetu et al., 2020; Vivas et al., 2010). More practical ways need to be developed to teach hygiene and sanitation topics to improve daily practice among children. A program that creates awareness about the benefits of deworming and water sanitation and hygiene practices can effectively reduce worm infestation rates and re-infections.

### 2.3.2 Micronutrient Supplementation and Food Fortification

Evidence shows that supplementation and fortification programs can be useful in improving the nutritional status of the targeted population (Faber et al., 2014), and to some extent, can be successful without changing the existing dietary patterns. Besides the routine facility-based vitamin A supplementation (VAS) at the maternal and child health clinics, mass vitamin A supplementation is provided to children of between 6-59 months twice a year. Post-partum mothers and those who are critically ill are also eligible for VAS (Kenya National Bureau of Statistics, 2015; Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016). The disadvantage of supplementation as a strategy is that it only targets a specific age group (Faber et al., 2014; Kenya National Bureau of Statistics, 2015; Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016). For instance, World Health Organization does not recommend VAS for children above five years of age (Republic of Kenya (MoH), 2016).

Iron and folic acid supplementation also target women of reproductive age and it is assumed that iron supplementation prevents anaemia often without considering other factors related to anaemia that cannot be managed through iron supplementation (Karakochuk et al 2017). A Cambodian study that assessed the effect of iron supplementation on hemoglobin concentration among non-pregnant women of reproductive age found that only 36% of anemia cases could be managed through iron supplementation because of other contributing factors to anemia, including nutritional, hematologic, inflammation-related, and genetic factors (Karakochuk et al., 2017). People with micronutrient deficiencies are also assumed to access health-care services regularly, which is not always the case (Chepkirui, 2019.

Food fortification is an equally viable approach (WHO, 2010); food manufacturing companies have collaborated with the government to ensure that essential food commodities are fortified with micronutrients (Chepkirui 2019; Kiige, 2004; WHO, 2010). For instance, maize flours, margarine, fats, sugar and salt have been fortified with vitamin A, iron, zinc, thiamine, riboflavin, folic acid, niacin, and vitamin B12, among other micronutrients (Republic of Kenya (MoH), 2011; WHO, 2010). However, fortified foods are generally more expensive, therefore, are less preferred by those living in poverty due to the additional cost (Kiige, 2004). A study in Guatemala showed that consumption of fortified flour was higher among economically empowered families than among poor households (Imhoff-Kunsch et al., 2007). In Kenya, 75% of the population live in rural areas; therefore, they eat substantial amounts of produce directly from the farm; hence their use of fortified products is limited (Chepkirui, 2019; Food and Agricultural Organization, (FAO), 2017). Lack of awareness about the benefits of these fortified products and supplements also affects their uptake in rural areas (Chepkirui, 2019). In a study conducted in Kajiado, Kenya, mothers reported that they witnessed their children given vitamin A supplements but were not aware of its benefits (Kiige, 2004).

Both supplementation and fortification are nutrient-based approaches that do not address the underlying cause of micronutrient malnutrition, which is food insecurity (Blasbalg et al., 2011; Faber et al., 2014). Therefore, these approaches may not be the most appropriate in addressing micronutrient malnutrition in rural or ultra-poor households (Berti et al., 2014). A multifaceted approach is required to tackle micronutrient malnutrition: programs that provide nutrition education, promote dietary diversification, increase awareness of nutritious foods and what comprises a healthy diet are needed (Blasbalg et al., 2011; Chepkirui, 2019; Darnton-Hill, 2014; Oldewage-Theron & Napier, 2011; Republic of Kenya (MoH), 2011; Thompson & Amoroso, 2014).

### 2.3.3 School Feeding Programs

School feeding programs (SFP) are complementary to learning and nutrition knowledge retention among children (Government of Kenya & WFP, 2017). They aim to meet the physiological and energy requirements of school-age children during their school days. Most school feeding programs have been judged to be successful since they achieve their primary objective: the immediate benefits that come with providing meals (Fernandes, 2018; Wang & Fawzi, 2020). Schools with school feeding programs have reported increased student concentration in class, improved overall school performance, and reduced absenteeism, among others (David et al., 2008; Wang & Fawzi, 2020). However, most school feeding programs are concerned with quantity and not the nutritional quality of the foods served to children (Harding et al., 2012). Both the quantity and quality of foods served in schools need to be considered in equal measure to meet both short and long-term goals of satiety and reduction of micronutrient malnutrition (Hongo, 2003). Despite the benefits of such programs in addressing hunger and mitigating MM, it is also important to complement such efforts with preventive community nutrition services like nutrition education in schools. It is also worth noting that school feeding programs are widely operational in developed countries, with very few in low and middle-income countries (Wang & Fawzi, 2020). In Kenya, a developing country, there are very few school-based feeding programs in rural areas (Ochola & Masibo, 2014; World Food Program, 2018). Specifically, public primary day schools in Homa-Bay do not have school-based feeding programs; therefore, this strategy may not be used to mitigate MM among school-age children in this region (Ochola & Masibo, 2014). It is assumed that children take breakfast at home in the morning before going to school, and when they are released to go home during lunch break and later in the evening, which is not always the case (Ochola & Masibo, 2014). Many children go to school without breakfast and do not carry snacks to eat during the time spent in school (Food and Agricultural Organization, (FAO), 2017; Ochola & Masibo, 2014). This practice has been associated with a high rate of absenteeism, poor concentration in class, low school enrollment rates, high school drop-outs rates, and undernutrition (Food and Agricultural Organization, (FAO), 2017; Government of Kenya & WFP, 2017; Ochola & Masibo, 2014; Wang & Fawzi, 2020). For these reasons, a program that meets both the short and long-term nutritional needs of school children is required. This study will give an insight into how vegetables can be grown in school gardens to sustain regular consumption at school and home. It will also provide a curriculum for future Farmer’s Helping Farmers nutrition education work with school children.

### 2.3.4 Nutrition Education in Schools

Nutrition education is the process of delivering nutrition information using educational strategies in a supportive environment to help children establish appropriate eating behaviours (Wallen & Davis, 2010). It can significantly improve the knowledge and practices of school-going children since it strengthens their capacity to understand, analyze, and make independent decisions regarding food selection (Stojan et al., 2012; World Food Program, 2018). Schools provide a robust environment with readily available resources that promote nutrition learning and the practice of healthy eating habits (Food and Agricultural Organization, (FAO), 2017; Hongo, 2003). Besides the family environment, children also learn new eating habits from their social interactions with friends in school. They play and eat together, a factor that is very important in shaping their eating habits (David et al., 2008). They can learn about healthy food choices, which can be modified easily, given their age (Stojan et al., 2012).

The best chance to foster patterns of healthy food choices is when a person is young (Antwi et al., 2020; Oldewage-Theron & Napier, 2011; Stojan et al., 2012). Therefore, nutrition education should commence early in life so that as children grow into adulthood, they are empowered and well equipped to make sound decisions around food choices for themselves and their dependents (Oldewage-Theron & Napier, 2011; Stojan et al., 2012). Nutrition education in schools is also the best way to introduce recommended practices in the community since there will be a multiplier effect as children play and interact with family and friends within and outside the school environment (David et al., 2008; Stojan et al., 2012). This can likely contribute to the transfer of the practices learned in school to the community (Dargie et al., 2018). In Kenya, parents introduce children to food preparation and cooking at an early age, averaging between 8-10 years (David et al., 2008; Nyapera, 2021). However, many parents in developing countries do not have time to teach their children about food preparation or nutrition (David et al., 2008; Dujin, 2019); children often learn by observing when their parents cook and through trials (Shabiralyani et al., 2015; Stojan et al., 2012).

Like South Africa and other developing countries, school children in Kenya learn about nutrition in school since nutrition topics are included in all the teaching curricula from grade one to eight (Oldewage-Theron & Napier, 2011; Republic of Kenya (MoE), 2019) In 2018, the Kenya Institute of Curriculum Development rolled out a competency-based curriculum (CBC) to replace the old 8.4.4 system. This CBC has a different approach to learning that involves practical activities such as the establishment of kitchen gardens by pupils, clean-up activities, and other food-based strategies meant to improve the time spent on learning nutrition in school (Mwangi et al., 2019; Republic of Kenya (MoE), 2019) However, this curriculum has only been offered to grades one to four; grades five to eight are still taught using the 8.4.4 system that is more theoretical in its approach and is nutrient rather than food-based (Sempele, 2019). There is thus a need to provide a food-based learning approach to older children in primary school. This study will target grade six pupils who are still being taught using the original curriculum while also supporting the current competency-based curriculum that is currently being rolled out by the Ministry of Education, Kenya.

### 2.3.5 Food-Based Nutrition Education Programs

Food-Based Nutrition Education (FBNE) is an experiential approach to learning nutrition (Thompson & Amoroso, 2014). It is more effective in improving nutrition knowledge, attitudes, and practices since it involves both practical and theoretical nutrition learning (Blasbalg et al., 2011; Darnton-Hill, 2014; Kiige, 2004; Thompson & Amoroso, 2014). Previous studies have shown the effectiveness of various food-based approaches in improving nutrition outcomes. For example, a six-month nutrition education study conducted in the Netherlands that involved school children in the practical establishment and maintenance of healthy kitchen gardens, cooking and tasting vegetables harvested from the gardens reported increased knowledge, attitudes, and consumption of vegetables (Leuven et al., 2018). Similarly, a pulse-based study conducted with Ethiopian school-age children and their mothers indicated increased knowledge attitudes and consumption of beans (Dargie et al., 2018). There is a scarcity of information on food-based studies with school-age children in Kenya, especially in Homa-Bay County. This experiential approach to learning is applied in the competency-based curriculum currently being used to teach children in grades one to four where, practical hygiene and cooking lessons are taught in grade one, theory and practical kitchen gardening lessons are taught in grade 4 (Mwangi et al., 2019). Since the current grade six children in Kenya have not been exposed to experiential nutrition learning before, there is a need for food-based nutrition education for this group. This program used a curriculum that adapted the nutrition topics and content relating to iron, zinc, β carotene and Vitamin C in the CBC curriculum with content modified to suit the study participants’ culture, eating patterns, and level of cognitive development.

### 2.3.6 Kitchen Gardening

Kitchen gardening is the growing of crops, mostly fruits and vegetables, on a small piece of land in a homestead or school compound to promote easy access to a variety of nutritionally rich foods for home consumption (Kiige, 2004; Mohsin et al., 2017; Republic of Kenya (MoH), 2017). Kitchen gardening is a cost-effective food-based approach that promotes dietary diversification since the gardens ensure regular access to a wide range of micronutrient-rich fruits and vegetables (Blasbalg et al., 2011; Chepkirui, 2019; Leuven et al., 2018). Small scale farmers in developing countries such as Kenya are encouraged to produce various nutritious foods over cash crops which automatically lead to their consumption (Hodge et al., 2015). Two Kenyan studies conducted in Kericho and Kajiado indicated high levels of zinc, retinol, and serum ferritin among children from households with kitchen gardens than those without kitchen gardens (Chepkirui, 2019; Kiige, 2004). Likewise, results from a study conducted with school-age children in the Netherlands demonstrated increased knowledge attitudes and consumption of vegetables following a kitchen gardening intervention (Leuven et al., 2018). Several other studies have established that the more diversified a kitchen garden, the higher the consumption of a variety of micronutrient sources by the people who feed directly from their farms (Bushamuka et al., 2005; Chepkirui, 2019; Kiige, 2004; Mohsin et al., 2017)

In Kenya, three-quarters of the population live in rural areas and most own pieces of land where they practise different types of farming, including kitchen gardening (Food and Agricultural Organization, (FAO), 2017). They regularly practice small scale subsistence farming, which includes dairy farming, poultry, aquaculture, and kitchen gardening (Kenya National Bureau of Statistics, 2015; Walton et al., 2012). However, many households have kitchen gardens that primarily grow one or two vegetables, with kales being the most dominant (Chepkirui, 2019; Kiige, 2004) they are not diversified. A combination of nutrition education and food production through kitchen gardening could enhance the understanding of a healthy kitchen garden as one that features a greater variety of vegetables (Republic of Kenya (MoH), 2017). This could improve the practice of growing a variety of vegetables, increasing access to various micronutrient-rich vegetables, and reducing micronutrient malnutrition in both the short and long term (Chepkirui, 2019; Kiige, 2004; Leuven et al., 2018; Oldewage-Theron & Napier, 2011). In this study, participants attended theory lessons on kitchen gardening and were involved in practical demonstration sessions similar to the usual food production and preparation practices at home. The study is expected to improve kitchen gardening knowledge, attitudes and practices at the same time.

### 2.3.7 Farmers Helping Farmers: Combined Horticulture and Food-Based Nutrition Interventions

Farmers Helping Farmers (FHF) is a Canadian organization that has worked in Kenya for the past four decades to improve the livelihoods of rural families by allocating resources and implementing livelihood support and nutrition programs in the rural areas of Meru, Kenya. FHF has worked with dairy and women’s groups, offering agricultural extension services and training to enhance kitchen garden yields and provided vegetable seeds, water tanks, and irrigation equipment. Training provided by FHF and University of Prince Edward Island (UPEI) researchers has also improved milk production and sales for smallholder dairy farmers (Walton et al., 2012). FHF has also partnered with some schools in central Kenya to construct modern cook houses within the school compounds and developed vegetable gardens to contribute to healthy lunch meals for the children. The nutritional value of foods served to children has improved as a result of easy access to horticultural products from the school gardens. The cooks include vegetables such as carrots, orange-fleshed sweet potatoes and kales from the school gardens in the nyoyo, maize, beans and vegetable stew, served at lunchtime. To ensure the sustainability of horticultural farms, the organization established irrigation in schools, a component that involved the supply of water tanks for rainwater storage. The tanks have since benefitted the schools in several ways beyond the intended purpose, with some handwashing stations being installed to improve children's hygiene. Since 2010, FHF has also partnered with UPEI to initiate food-based nutrition education (FBNE) with local women's groups.

The FBNE training focused on how to incorporate nutritious crops from the kitchen gardens into family meals. The findings of a study conducted in the Meru area revealed an improvement in nutrition KAP of women who participated (Muthee, 2018). In Africa, many food-based nutrition programs target women since they are solely responsible for the choice of what to eat in a household at every mealtime (Hongo, 2003). Since few such projects in Kenya focus on children, FHF expressed interest in partnering with UPEI to carry out FBNE, which targets school-age children.

## 2.4 Research Gap

Several studies have been conducted and strategies implemented to mitigate micronutrient malnutrition in developing countries, including Kenya (Republic of Kenya (MoH), 2011). Despite all these efforts, the number of people suffering from micronutrient malnutrition remains high (Republic of Kenya (MoH), 2011; Republic of Kenya (MoH), 2016). It is therefore important to identify additional strategies to mitigate MM.

Farmers Helping Farmers has implemented livelihood support programs in Meru, Kenya, including initiating school gardening programs to improve the quality of foods served to school-going children. This international NGO has conducted a peer-led food-based nutrition education intervention with women in Meru, Kenya, that resulted in an increase in nutrition KAP and food consumption of the participants (Muthee, 2018); however, none with school children. The success of the research with women in Meru, coupled with the scarcity of information on any food-based nutrition programs engaging school children in Meru, Kenya, gave rise to the idea of conducting food-based nutrition education research targeting school children in Meru

This study aimed to assess the effects of a similar intervention on school-age children in the Meru area where the FHF organization is established. However, due to the Covid-19 global pandemic, the study area was changed to Ndhiwa in Homa-Bay, Kenya, where the researcher could access the participants using the community-based learning approach. Similar to Meru, Kenya, there is a paucity of information on any food-based nutrition education research conducted with school-age children in the Homa-Bay area.

This study seeks to assess the effect of specific food-based nutrition topics on grade six pupils who are taught using the old 8.4.4 curriculum. This nutrition education intervention is, therefore, to complement the original curriculum for grade six pupils.

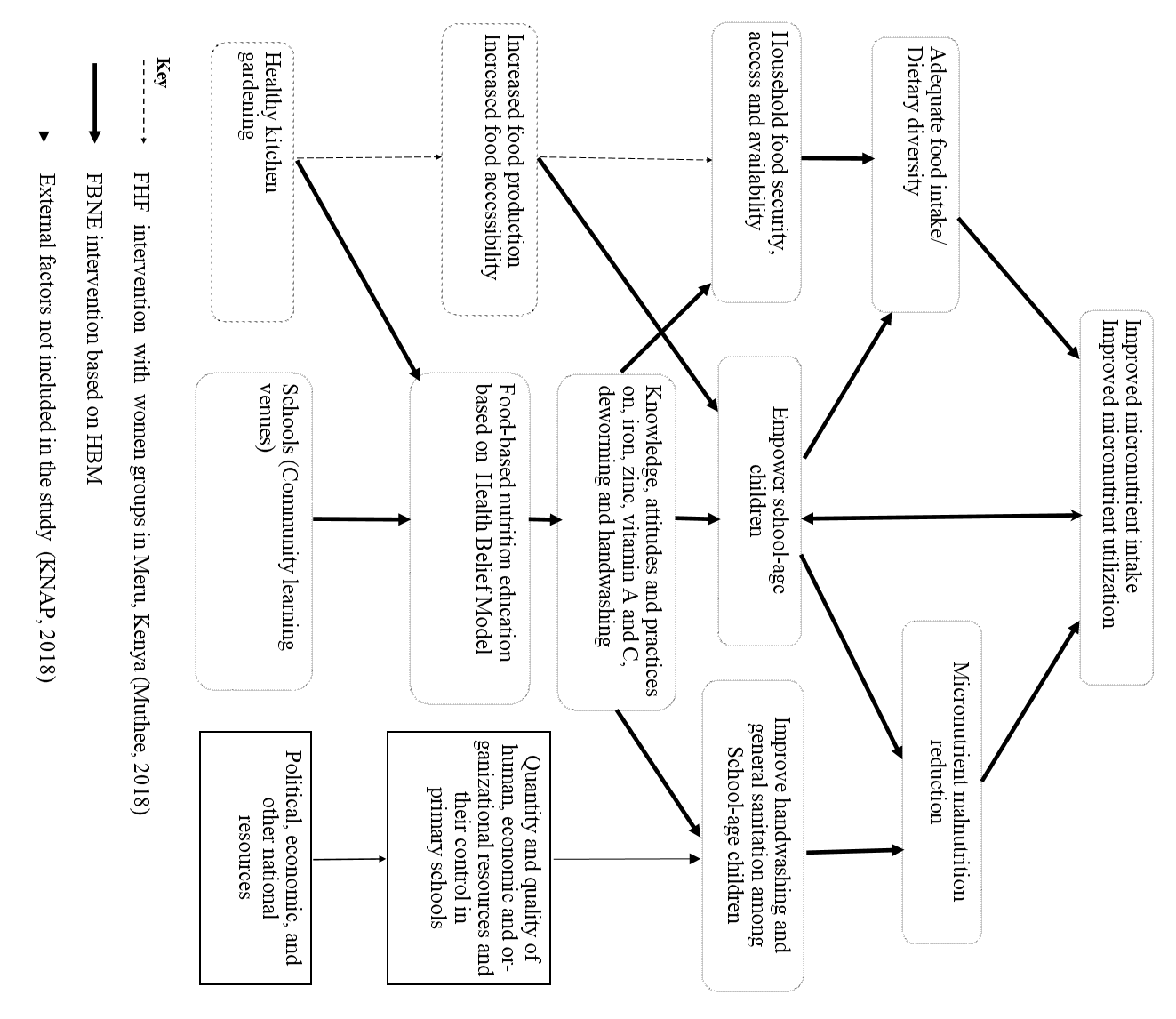
Overall, this study aims to assess the effects of food-based nutrition education interventions on nutrition KAP of school-age children with school children not receiving nutrition education.

## 2.5 Theoretical Framework

This study will be guided by the Health Belief Model (HBM), a framework for understanding how individual attitudes and perceptions explain the adoption of health behaviors, including eating behaviors (Adhikari, 2019). It is used either alone as a theoretical basis for health education or in combination with other learning models, approaches or theories (Adhikari, 2019) The HBM has six constructs (perceived’ susceptibility, severity, benefits, barriers, cues to action and self-efficacy) that provide a framework for curriculum development (Adhikari, 2019; Gipson & King, 2012; Naghashpour et al., 2014)

Several studies have demonstrated the efficacy of this model in explaining dietary behavior change in nutrition education settings (Gipson & King, 2012; Moitra et al., 2021; Naghashpour et al., 2014). An Iranian study based on the Health Belief Model that aimed to improve calcium intake among junior high school students indicated increased perceived severity, susceptibility, benefits, self-efficacy and decreased barriers (Naghashpour et al., 2014). Likewise, a study in Ethiopia showed a positive correlation between HBM and nutrition knowledge and practices among pregnant women (Diddana et al., 2018). Despite the recommendation that the HBM constructs be included in nutrition education programs and guidelines (Naghashpour et al., 2014) very few studies in developing countries, including Kenya, have used the HBM with children. The HBM is relevant and appropriate for this study because the pupils' perceptions of the severity of micronutrient deficiencies, their susceptibility to micronutrient deficiencies, and the benefits of adopting recommended food preparation practices designed to reduce MM and possible barriers to adopting the recommended practices are of interest. Therefore, the HBM will be used to identify relevant attitudes that will predict practices and possibly food use.

A conceptual framework for malnutrition adapted from the Kenya National Nutrition action plan (KNAP) for 2018-2022, was modified to illustrate the linkage between the study concepts and the micronutrient status of pupils (Republic of Kenya (MoH), 2018). The study components are also part of the interventions run by FHF in selected schools in Meru, Kenya. The framework gives a general guideline that explains how the concepts are related hierarchically based on the standard causes of malnutrition (basic, underlying, immediate and the expected outcomes following the proposed food-based nutrition education intervention). The focus of this study is highlighted in bold arrows in the conceptual framework below. Food-based nutrition education was offered to school-age children in selected primary schools when they reopened in January 2021. Participants were taught basic information on handwashing, and kitchen gardening, along with food-based strategies related to iron, zinc, vitamin A and C, using a curriculum developed (Appendix 4) based on the Health Belief Model constructs.

**Figure 1: Food-Based Nutrition Education Conceptual Framework**.

**Adapted and modified from Kenya Nutrition Action Plan, (2018)**

## 2.6 Aim of the Study

The aim of this study is to assess differences in food-related knowledge, attitudes, practices, and food consumption between children receiving a food-based nutrition education intervention and those who do not.

## 2.7 Specific Objectives

Specific outcomes for this study include the following:

* Todevelop a food-based nutrition education curriculum and questionnaires for evaluation based on the Health Belief Model to assess the outcomes of the intervention.
* To evaluate the effectiveness of a food-based nutrition education program by comparing children's food-related KAP and food consumption prior to and following an eight-week nutrition education program.

## 2.8 Research Hypothesis

1. Students receiving the food-based nutrition education intervention will have higher levels of food-related KAP and will consume recommended healthy foods more often following an eight-week intervention than students not receiving the intervention.

**Null hypothesis**

1. Students receiving food-based nutrition education intervention will have equal or lower levels of food-related KAP. They will also consume recommended healthy foods equally or less often as compared to the students not receiving the intervention.

# Chapter 3.0: Methodology

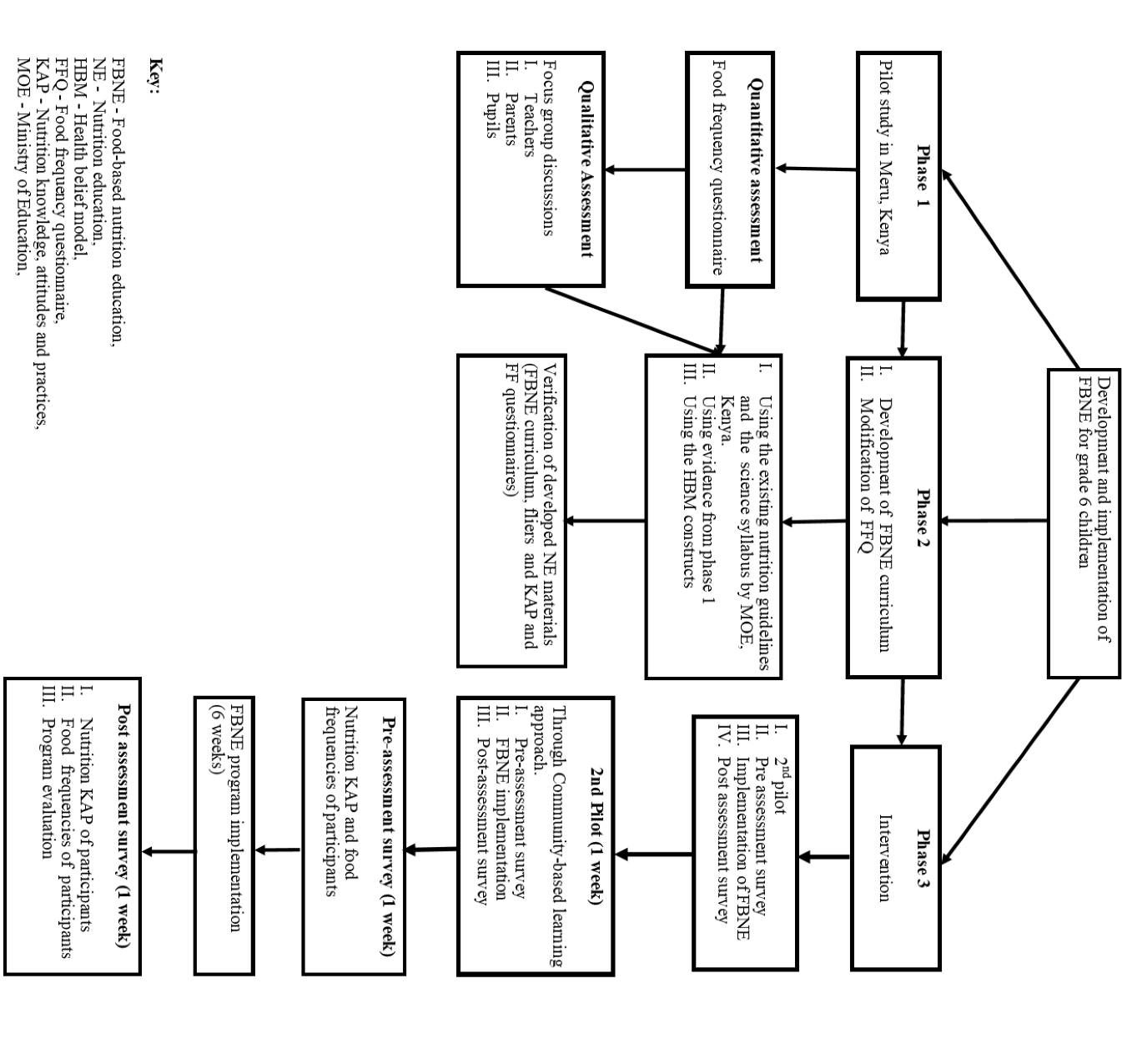
## 3.1 Program Design

A pre-post quasi-experimental design was used to assess the effect of a food-based nutrition education program on food-related knowledge, attitudes, practices, and food consumption on school-age children. Since schools in Kenya were closed due to the global pandemic, the Ministry of Education, Kenya proposed a community-based learning (CBL) program that was to involve administrators and teachers; the chiefs were to assemble learners who were to be arranged by teachers into groups of 15 for face-to-face learning with strict conformity to Covid-19 containment measures. The CBL was never implemented; however, its guidelines were applied to conduct a second pilot study that aimed to ensure cultural acceptability (Republic of Kenya (MoE), 2020; Republic of Kenya (MoH), 2020a).

In January 2021, the schools reopened, and learning resumed. The main research was conducted in schools, as was the original plan. The intervention group was comprised of three groups of 15 participants, each according to the community-based learning guidelines. The comparison group consisted of an equal number of participants who did not receive the intervention. They will receive the intervention after the study is concluded.

Data related to children’s food-related knowledge, attitudes, practices (KAP), as well as food consumption, was collected using an in-class survey one week before and one week following the six-week food-based nutrition education program. The pre- and post-surveys were completed by both the intervention and the comparison groups.

*COVID-19 containment measures*: The training was conducted in rooms with good ventilation, according to Kenya’s Ministry of Health and Education guidelines (Republic of Kenya (MoE), 2020; Republic of Kenya (MoH), 2020). Handwashing facilities with soap, water and paper towels were provided at the training venues for the participants. In addition, temperature checks were conducted at the beginning of every lesson.

Figure 2: Overview of the Study Protocol

## 3.2 The Food-Based Nutrition Education Intervention

The objective of food-based nutrition education interventions is to increase KAP regarding food selection, preparation, parasite prevention, and improve diet quality. The nutrition education curriculum consisted of both theoretical and practical sessions, and it was guided by the nutrition messages used for previous interventions among women’s groups in the Meru area of Kenya by (Muthee, 2018) Historically, some cultural differences distinguish food and nutrition practices of the Meru, who are Bantus, from Luos, who are Nilotic, (FAO/Government of Kenya, 2019). The food-based education curriculum, food frequency questionnaire (FFQ) and key messages were modified to be relevant to the Luo culture. This food-based nutrition curriculum was meant to complement the nutrition components of the Kenyan science curriculum and was based on the Health Belief Model (HBM) constructs described in Table 1 below.

The intervention was expected to improve the participants’ understanding of their perceived susceptibility to micronutrient deficiency, the severity of MM among school-age children, the benefits and importance of following recommended practices and behaviours that would help maintain good micronutrient status. Further, children would be able to identify means of reducing identified barriers to recommended practices and behaviours. Self-efficacy was not assessed as part of this study.

The curriculum was implemented over eight weeks: one week of introducing the program and collecting pre-intervention data, six weeks of nutrition education teaching, and one week of collecting post-intervention data. The nutrition curriculum was divided into six lessons focusing on food-based strategies to enhance iron, zinc, and vitamin A and C intake and prevent or reduce parasite infestation (Appendix 4). Participants learnt about food sources of these specific micronutrients (e.g., nyoyo, kales and beans) and food preparation methods that maximize nutrient content and preserve these nutrients for absorption. In all instances, nutrition messages used previously in the Meru region with women’s groups were adapted. These messages emphasized how to enrich staple foods with locally available food sources, with a focus on the vegetables that are promoted and supported by FHF projects.

Participants were also encouraged to explore other dietary sources available in the community to improve the consumption and utilization of these nutrients from the food sources consumed. Participants were involved in both theoretical and practical lessons on practices that preserve these vitamins during cooking for example, adding green leafy vegetables into nyoyo during the last 15 minutes of cooking or cooking green leafy vegetables for 10-15 minutes and adding fat or oil into foods during cooking to enhance absorption of β-carotene by the body since it is fat-soluble (Republic of Kenya (MoH), 2017). Further, they were taught alternative ways of preparing these foods to improve their uptake. The participants also learnt the roles of specific nutrients in the human body, symptoms indicative of deficiency and food sources, in addition to how to access these nutrients through foods grown in a healthy kitchen garden. The promotion of the addition of vegetables to various foods, especially nyoyo (that is consumed regularly), was to supply the nutrients that are missing or are in negligible amounts in these staple foods. The maize and beans meal (nyoyo) was enriched by adding orange/yellow /green vegetables in addition to the tomatoes and onions that were regularly used in cooking. During the practical sessions, commonly consumed foods like maize and beans were provided to the participants and methods of preparation were demonstrated.

The strategy of soaking maize, beans and other cereals and grains was used to increase the likelihood that the children would accept the messages and prepare the foods in their homes according to the messages. Soaking is meant to reduce anti-nutritional compounds such as phytates, phytic acid, tannins, and phenolic compounds, increasing iron and zinc bioavailability and conserving the B vitamins (Fernandes, C. et al., 2010). It also reduces oligosaccharides in beans, grains and seeds which cause flatulence and stomach discomfort. In addition, it saves cooking time and fuel (Jian et al., 2017). Similarly, the fermentation of porridge also reduces nutrient inhibitors and increases the bioavailability of iron and zinc nutrients in the body, hence can potentially reduce micronutrient malnutrition (FAO/Government of Kenya, 2019; Kunyanga et al., 2010). Participants prepared nyoyo and porridge using the recommended techniques. All sessions were conducted in English, one of the co-national languages in Kenya.

|  |  |
| --- | --- |
| Table 1. Health Belief Model Constructs | |
| HBM construct | Its application in the food-based nutrition education intervention. |
| Perceived susceptibility | Pupils’ belief that they are at risk of MM deficiencies and complications related to iron, zinc, vitamin A and C when they do not consume adequate amounts of these micronutrients in the diet. |
| Perceived severity | Pupil’s knowledge and beliefs regarding the consequences of an inadequate intake of dietary iron, zinc, β carotene and vitamin C. |
| Perceived benefits and perceived barriers | Benefits: Improvement of micronutrient status, strengthened immunity, improved vision and shortened cooking time etc.  Barriers: E.g., water shortage preventing regular handwashing and soaking of cereals and legumes, financial constraints, culture, inadequate knowledge /understanding of the benefits of various recommended practices and the consequences of not practising them. |
| Taking preventive nutrition and health-related actions | Increasing dietary intake of these micronutrients |

## 3.3 Sample Selection

Initially, the research was to be conducted in selected schools that were already working with the FHF organization in Meru, Kenya. However, due to the changes that resulted from the current Covid-19 global pandemic, the study area was changed from Naari and Buuri in Meru County to Ndhiwa in Homa-Bay County, Kenya. The researcher selected Minya village for piloting and used the free community learning approach guidelines by the Ministry of Education, Kenya to access and to conduct a pilot study. In January 2021, the schools re-opened. The researcher, therefore, used the original data collection strategy. Six schools were selected from Kanyadoto and Kanyikela wards based on convenience. The six schools were randomly allocated to the intervention and control groups (three schools in each group). With the help of the head teachers, all grade 6 children in the six schools were introduced to the food-based nutrition program and given consent forms to take to their parents for signing. Out of those who gave their assent to participate following their parents’ consent, 15 participants were randomly selected in each of the 6 schools: 45 from the intervention and 45 from the comparison schools. To allow for dropouts, 15 participants were added to each group. All children and researchers adhered closely to Kenya’s COVID-19 prevention measures; participants were provided with masks, handwashing facilities with soap, water and paper towels and were limited to 15 per class (Republic of Kenya (MoH), 2020; Republic of Kenya (MoE), 2020).

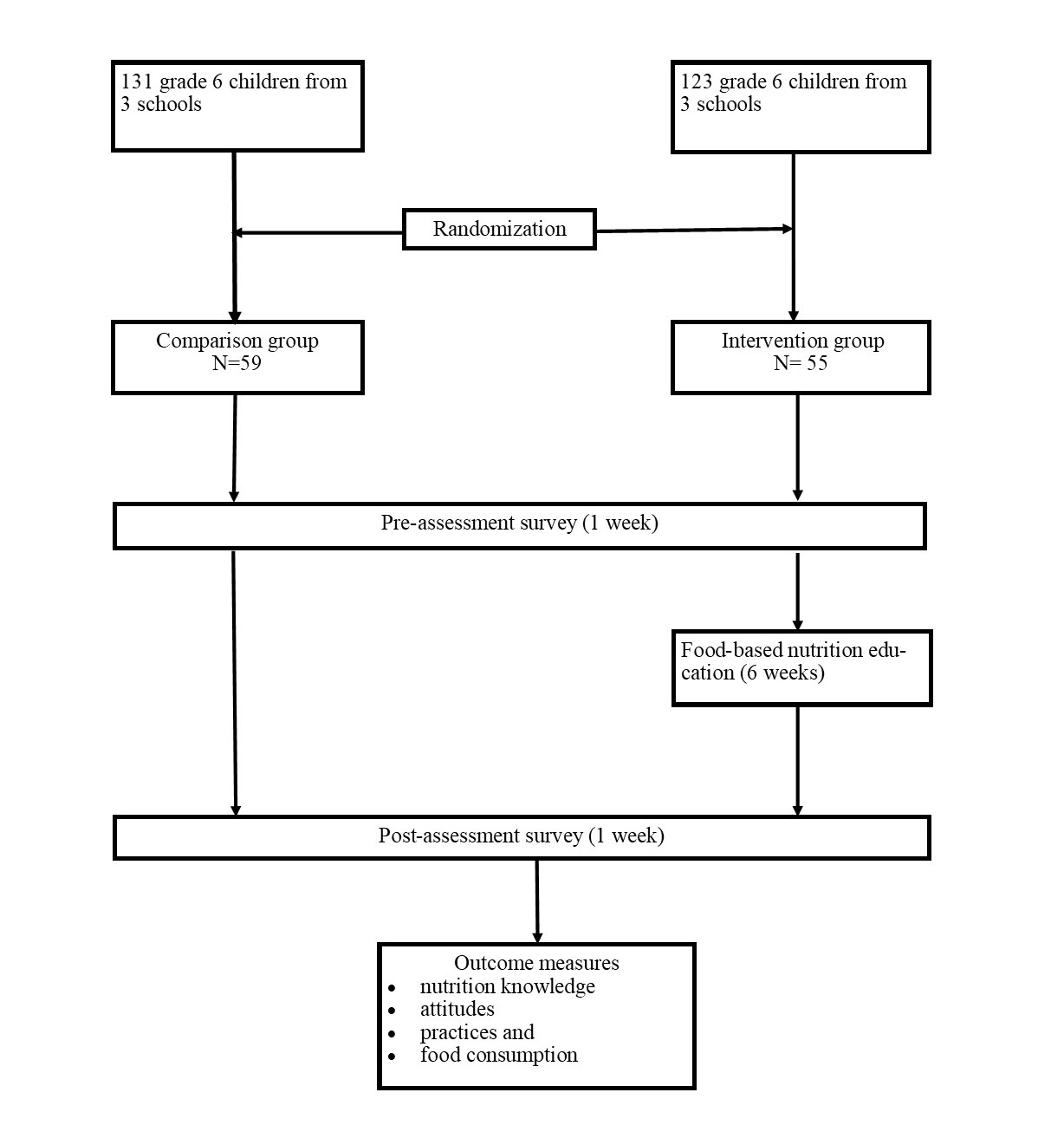


Figure 3. Study Design

## 3.4. Data Collection Instruments

### 3.4.1 Questionnaires

A semi-structured questionnaire to assess food-related knowledge, attitudes, and practices and a food frequency questionnaire (FFQ) used previously in a peer-led nutrition education intervention for women in Meru County in 2016-2019 were modified for this study. The questionnaires are described separately below.

*Food Frequency Questionnaire Development*: A previously developed food frequency questionnaire used in a research project examining the effectiveness of a food-based nutrition education program in Meru County, Kenya was adapted (Muthee, 2018). The original FFQ included 35 food groupings based on similar nutritional content. Commonly used foods were included to capture women's intakes of foods high in β-carotene, iron, vitamin C and zinc. A pilot test was conducted to gauge the suitability of the FFQ to grade six children in Meru. All grade six children in the three schools in Meru were selected for the pilot, and five science teachers (at these same schools completed the FFQ). Six girls and six boys (among those who completed the FFQ) were then selected for a focus group discussion (FGD) to assess the participants' experiences in completing the FFQ and obtain their comments on its relevance and suitability to grade six children. The five science teachers per school who completed the FFQ also participated in an FGD. Questions included the challenges pilot participants faced in completing the questionnaire, the ease of understanding the questionnaire, their familiarity with the foods listed in the FFQ and suggestions of ways to overcome the challenges they listed to improve the children's understanding of the FFQ. A dietetic intern who was part of the research team recorded all comments. These comments were examined for themes and commonalities and are described below.

*Suggested revisions*: Children and teachers identified the nature of food groups in the FFQ as a concern. They suggested that chicken and chicken organ meats be combined since, whenever they ate chicken, it included its organ meat: chicken is slaughtered at home, and everything is cooked in one pot. Children also recommended that goat meat, sheep, and beef be put under one group named ‘meat.’ According to them, most children are unable to identify different types of meat unless their parents tell them, or when they can identify the animal after seeing it slaughtered at home. They also suggested the inclusion of amaranth leaves and stinging nettle in the FFQ since these were commonly consumed vegetables. Children also suggested that having a list of all dishes prepared from a specific food would help them to recall what they ate. For example, the number of times they consumed maize could be recalled more accurately if the questionnaire specified that they should consider the number of times they ate maize in ugali, nyoyo and porridge; similarly, milk should include tea and or plain milk. Finally, the original food grouping called “sweets” that included soda, sweet drinks, pastries, mandazi, doughnut, cakes, candies and chocolates was misunderstood by the children, and this led to misinterpretation. In the Kenyan context, sweets are known to be a group name for various types of candies. The children thus reported only the number of times they ate candies since they focused on the word “sweets.” It was suggested that all the foods in this category be split into “sweets” that would contain candies, “sweet drinks” that would contain sodas and any other sweet drinks, and “bakery products” that would include cakes, mandazi, chapati and other pastries. Both the teachers and children also indicated that four weeks was a very long period to recall which foods were consumed and how often. Although teachers suggested that the pupils be given a diary to record their daily meals for four weeks, this would be challenging logistically. The FFQ questionnaire was revised in light of these findings, including re-grouping and re-naming the foods and decreasing the time frame to one week to increase; children’s understanding, the accuracy of the data collected and to ensure revisions made are consistent with study objectives. Since the study was later relocated to Homa-Bay County, the revised FFQ was piloted a second time to ensure cultural relevance (described below).

*Food-related Knowledge, Attitudes, and Practices Questionnaire:* A semi-structured knowledge, attitudes, and practices (KAP) questionnaire from a recent study with women’s groups in the Meru area was adapted for the current study (Muthee, 2018). There were 48 questions included in the questionnaire including sections on knowledge, attitudes and practices relevant to the nutrition education intervention based on the Health Belief Model constructs, of susceptibility, severity, benefits, barriers and health and nutrition prevention actions. The questions were primarily close-ended, and they focused on children’s knowledge of recommended food preparation practices, their attitudes towards these recommended practices, and whether or not these practices were being implemented at home. Participants were asked KAP and food consumption questions related to each key message. For instance, they were asked to report whether they knew about soaking (cereals and legumes) maize and beans before cooking nyoyo (practice), whether they understood why they should soak (knowledge), how important they thought it was to soak maize and beans (attitudes), and if they consumed nyoyo made of maize and beans or legumes in general that have been soaked before cooking (consumption).

*Questionnaire* *Pilot in Homa-Bay*: The research setting had to be moved to the home region of the researcher because of the global pandemic. Therefore, the FFQ was adapted for the Ndhiwa students in the Homa-Bay County region. A full pilot of the research tools (curriculum and the data collection tools) was conducted in Minya, a village in Homa-Bay that did not participate in the research. The pilot was conducted by the researcher with the support of a research assistant and a nutrition faculty member from Kenyatta University (Dr Judith Munga).

Following a revision to the KAP questionnaire, it was also pre-tested on grade six children at Minya village to ensure comprehension and to determine the time needed for completion. Fourteen grade six children completed the food frequency and KAP questionnaires before and after one week of the program. Findings were used to modify the questionnaires further to ensure they were relevant and understandable to the local culture.

*Second pilot report:* The food-based nutrition education research was piloted for one week on seven boys and seven girls from Minya village/primary school. During the pretest, it was noted that some food items in the FFQ were not familiar to the participants since they were not grown or sold in the surrounding environment. The questionnaires were thus modified to adapt them better to the western Kenya/Luo culture. The food items with nutritionally equivalent sources found in the Ndhiwa community replaced those grown in Meru, Kenya. For instance, amaranth leaves, pumpkin leaves, black nightshade, spider plants are among the green leafy vegetables available in western Kenya. In the FFQ, the local names of the food items were added beside the English names for easier understanding. The KAP questionnaire was also translated into the local Luo language. A consistent approach was also used to deliver nutrition messages. Both the FFQ and KAP questionnaires took approximately 2 hours and 30 minutes to complete during pretests and 1 hour 30 minutes during post-test.

## 3.5 Ethical Considerations

Approval to conduct the study was obtained through the University of Prince Edward Island Research Ethics Board, National Commission for Science, Technology and Innovation (NACOSTI), Farmers Helping Farmers, and the Ministry of Education, Homa-Bay County. The administrative officers (chiefs) of the locations of the selected village and schools also granted permission to conduct the study. Consent forms and information letters were sent home with all the participants in the community/schools. Only those children with consent from parents and who provide their assent participated.

## 3.6 Data Collection

The pre-assessment survey was conducted in January 2021 (pre-intervention) and post assessment, March 2021. The research team and the selected teachers agreed on the appropriate time for administering the questionnaires during the first and the final classes of nutrition education program implementation.

The participants completed the KAP and FFQ questionnaires under the supervision of the research team with the support of a designated teacher. The process of completing the FFQ and KAP took approximately 1 hour and 30 minutes. The research team read the instructions and demonstrated how to complete the FFQ by using food items that were not on the food frequency questionnaire. The post-assessment survey was completed one week after the completion of the implementation of the food-based program.

## 3.7 Data Handling and Analysis

All the data collected were coded, entered into Microsoft Excel spreadsheets, and checked for accuracy. A probability of p < 0.05 was regarded as significant. All analysis was conducted using SAS (9.4).

For the FFQ, each participant’s daily food use was calculated as follows: ‘Rarely or Never’ was recorded as 0; ‘once a week to three times a week’ was recorded as 0.29; ‘four to six times a week’ was recorded as 0.71 and ‘daily’ was recorded as 1. These values were summed for each participant to yield an ‘average daily intake’ or ADI. The ADIs were further collapsed into three frequency categories: 1 serving = daily, 0.29-0.71 servings = weekly and 0 servings = less than weekly (Evers et al., 2001).

Data was imported into statistical analysis system software (SAS) and tested for normality using the Shapiro-Wilk test. Since the data distribution was found to be non-normal, a non-parametric test, the Wilcoxon signed-rank test, was used to compare mean scores within the intervention and comparison groups. Descriptive statistics were generated for both continuous and categorical variables. Chi-square analysis was used to assess differences in demographic characteristics between the intervention and comparison groups.

Group differences in terms of the frequency of food use (daily, weekly, or less than weekly), before and after the nutrition intervention were assessed using chi-square analysis. The same test was used to determine the differences within the intervention group before and after the nutrition intervention as well.

The responses to knowledge questions were coded as either correct (1) or incorrect (0). Each set of knowledge questions were handled independently according to the nutrient of interest. For instance, the sum of correct answers for vitamin A, C, zinc and iron-related knowledge questions and sanitation-related knowledge questions were calculated independently. Knowledge scores were standardized for each category of questions by dividing the sum of correct responses in each nutrient group by the number of questions. Chi-square test was also used to analyze the proportion of children within intervention and comparison groups who selected correct answers for each category of knowledge questions, pre- and post-intervention. Wilcoxon sign rank tests were used to evaluate the differences in the mean knowledge category scores before and following the intervention within the intervention and comparison groups.

An attitude score was created for each of the three sets of attitude questions, again grouped by nutrient of interest. Attitude questions were recoded based on the frequency of responses; the responses for each question were dichotomized to “Important’ and “not important”, “difficult”, and “not difficult” categories. The Chi-square test was used to analyze the frequency distribution within the intervention and comparison groups pre- and post-intervention. Post assessment mean attitude scores were compared within the intervention and the comparison groups using the Wilcoxon sign rank tests.

As for the practice questions, the sum of all recommended responses for the practice questions in each nutrient category was divided by the number of practice questions in that category. Responses were grouped into categories according to the distribution of responses e.g., the proportion of children implementing all or part of the iron and zinc practices. Similar to the knowledge data, the responses for practice questions were recoded into categories depending on the distribution of the data (e.g., the proportion of children who practiced less than one message versus greater than one). Chi-square tests were used to analyze the proportion of children within the intervention and comparison groups who reported implementing the recommended practices, pre- and post-intervention. Wilcoxon signed-rank test was also used to evaluate the differences in the mean practice scores of the intervention and comparison groups.

# Chapter 4.0: Results

The results section of this thesis is organized as follows. After the sample description, the knowledge, attitudes, barriers and practices are presented according to each category of nutrition message, including handwashing and sanitation, iron and zinc, vitamin A and C, and kitchen gardening.

## 4.1 Sample Description

Table 2 represents the demographic characteristics of the intervention and comparison groups. There were no differences in gender distribution between the groups, 56.4% and 52.5% girls and 43.6% and 47.5% boys in the intervention and comparison groups, respectively. However, there was a significant difference in the age distribution of the participants with a higher proportion, 50.9% being children between 9 to 13 years of age in the intervention group and a higher proportion 47.5% being 13 years of age (P=0.002) in the comparison group.

Table 2. Demographic Information

|  |  |  |  |
| --- | --- | --- | --- |
|  | Intervention | Comparison | P1 |
| Gender distribution | %(n) | %(n) |  |
| Female | 56.4(31) | 52.5(31) | 0.68 |
| Male | 43.6(24) | 47.5(28) |  |
| Age distribution |  |  |  |
| 9-13 years | 50.9(28) | 25.4(15) | 0.02 |
| 13 years | 32.7(18) | 47.5(28) |  |
| 13-17 years | 16.4(9) | 27.1(16) |  |
| Grade | 6 | 6 |  |

1Pearson chi-square.

## 4.2 **Handwashing and Sanitation Knowledge Attitudes and Practices**

### 4.2.1 Pre-post Handwashing and Sanitation Knowledge and Scores in the Intervention and Comparison Groups

Table 3 describes the proportions of participants who had correct answers for sanitation questions prior to and following the study. There was a significant increase in knowledge of the correct handwashing procedures over the study in both the intervention (p=0.0002) and comparison groups (p=0.0001). Above 95% of the participants in both groups were also highly knowledgeable about the reasons for handwashing prior to and following the intervention. There was no significant change in either group regarding the number of participants who knew the correct reasons for handwashing. Despite registered improvement in the mean scores post-intervention for both groups, sanitation knowledge scores did not change significantly in either the intervention or comparison group (Table 3).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 3: Proportion of participants in the intervention (n=55) and comparison (n=59) groups who had correct answers for the sanitation knowledge questions and scores prior to and following the food-based nutrition intervention. | | | | | | | | | | | |
| Question category | |  | | Pre  % (n) | | Post  % (n) | | ꭕ2 | | P1 | |
| What is the correct handwashing procedure | | Intervention  Comparison | | 43.6(24)  52.5(31) | | 78.2(43)  79.7(47) | | 13.8  9.7 | | 0.0002  0.0001 | |
| Why do we wash our hands? | | Intervention  Comparison | | 96.4(53)  96.4(54) | | 96.4(53)  100.0(59) | | 0.0  2.0 | | 1.00  0.15 | |
|  |  | | **Pre-Mean (±SD)** | | **Post Mean (±SD)** | | **Difference Mean (±SD)** | | **S** | | **P2** |
| Sanitation knowledge score | Intervention Comparison | | 0.84±0.20  0.69±0.24 | | 0.93±0.14  0.77±0.19 | | - 0.06±0.17  - 0.08±0.26 | | - 7  - 79 | | 0.22  0.13 |

1Pearson chi-square

2Wilcoxon Signed Rank Test paired comparison

### 4.2.2 Pre-post Handwashing and Sanitation Attitudes and Scores in the Intervention and Comparison Groups

Prior to the intervention, 81.8% of the intervention group described regular use of clean and clean water as important/very important. This number increased significantly to 94.5% following the intervention (Table 4; p=0.04), with no change in the comparison group. There was also an increase from 80% to 90.9% of participants who described deworming practices as “important” and “very important” in the intervention group while a slight decline from 81.4 % to 74.6% was observed in the comparison group, the differences were not significant (p=0.10; p=0.37). Positive attitudes towards handwashing were observed in both study groups pre-intervention that increased though not significantly post-intervention in the intervention group from 90.9% to 92.7%. The comparison group, on the other hand, registered a significant decline on the same from 88.1% to 72.9%; p=0.04. Similarly, the handwashing and sanitation attitudes mean score increased significantly in the intervention group (p=0.01) but remained similar in the comparison group at p=0.22.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table 4 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who described recommended practices concerning sanitation as “important/very important” and “difficult” and attitudes scores prior to and following the food-based nutrition education intervention. | | | | | | | |
| Answers with category | | | | Pre | Post | ꭕ2 | P1 |
| *Important/very important* | |  | | %(n) | %(n) |  |  |
| Regular handwashing | | Intervention  Comparison | | 90.9(50) 88.1(52) | 92.7(51) 72.9(43) | 0.1  4.4 | 0.73  0.04 |
| Deworming | | Intervention  Comparison | | 80.0(44) 81.4(48) | 90.9(50) 74.6(44) | 2.6  0.8 | 0.10  0.37 |
| Regular use of clean and safe water | | Intervention  Comparison | | 81.8(45) 77.9(46) | 94.5(52) 79.7(47) | 4.3  0.1 | 0.04  0.82 |
| *Difficult* | |  | |  |  |  |  |
| Regular handwashing | | Intervention  Comparison | | 29.1(16)  67.8(40) | 23.6(13) 42.4(25) | 0.4  7.7 | 0.52  0.006 |
| Deworm | | Intervention  Comparison | | 38.2(21) 76.3(45) | 25.4(14) 59.3(35) | 2.1  3.9 | 0.15  0.05 |
| Use clean and safe water regularly | | Intervention  Comparison | | 27.3(15) 45.8(27) | 18.2(10) 39.0(23) | 1.3  0.6 | 0.26  0.46 |
|  |  | | **Pre Mean ± SD** | **Post Mean ± SD** | **Difference Mean ± SD** | **S** | **P2** |
| Handwashing and sanitation attitudes score | Intervention | | 1.77±0.24 | 1.85±0.20 | - 0.08±0.23 | - 131.5 | 0.01 |
| Comparison | | 1.60±0.22 | 1.64±0.27 | - 0.05±0.30 | - 108.5 | 0.22 |
|  | |  |  |  |  |  |

1Pearson chi-square

2Paired comparison using Wilcoxon Signed Rank Tests

### 4.2.3 Pre-post Handwashing and Sanitation Practices and Scores in the Intervention and Comparison Groups

The graphs below show handwashing practices during the four critical times, after visiting the toilet, before eating, before preparing food and after changing baby diapers. As shown in figure 4, there was a significant increase from 27.3% to 54.6%; p=0.001 in the number of participants who washed hands after changing diapers in the intervention. This was similar to the comparison group, where the proportion of participants who washed hands after changing diapers also increased from 34.6% to 43.6% at p=0.01. There was a slight improvement in the number of participants who reported handwashing “before eating” from 76.4% to 81.8 % and 37.3% to 45.8% in the intervention and comparison groups, respectively; however, the differences were not significant. The proportion of participants who washed hands “before preparing food” also increased from 34.6% to 43.6%, in the intervention group and in contrast, there was a decrease in the comparison group from 33.9% to 25.4%; however, the differences were not significant in the two groups. Overall, there was a significant mean increase of -0.15 ± 0.48 at p=0.003 in the handwashing practices score of the intervention group and none in the comparison group (p=0.12).

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| --- | --- | --- | --- | --- | --- |
| Table 5 : Handwashing and sanitation practices mean scores in the intervention and comparison groups prior to and following the intervention | | | | | |
|  | Pre  Mean ± SD | Post Mean ± SD | Difference Mean ± SD | S | P1 |
| Intervention | 1.30±0.43 | 1.45±0.42 | - 0.15±0.48 | -135 | 0.03 |
| Comparison | 1.06±0.45 | 1.18±0.48 | - 0.11±0.53 | -131.5 | 0.12 |

1Paired comparison using Wilcoxon Signed Rank Test

Figure . Proportion of Participants in the Intervention Group (n=55) who Washed their Hands “Always” During the Four Critical Times

\*\*\* p=0.001

Figure . Proportion of Participants in the comparison Group (n=59) who Washed Hands “Always” during the Four Critical Times

\*\*\* p=0.001

## 4.3 Iron and Zinc Knowledge, Attitudes and Practices

### 4.3.1 Pre-post Iron and Zinc Knowledge and Scores in the Intervention and Comparison Groups

There was a significant mean increase of -0.36 ± 0.45; p=0.0001 in the intervention group's average iron and zinc knowledge scores and none in the comparison group (0.00 ± 0.39; p=1.00) (Table 6). The number of participants who identified the benefits of soaking correctly in the intervention group almost doubled from 23.6% to 52.7% at p=0.002. Similarly, the number of participants who identified soaking as the method that preserves iron and zinc in maize and beans also increased significantly from 47.3% to 90.9%; p<0.0001 in the intervention group following the intervention. There were no changes in performance in the comparison group following the intervention.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 6 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who had correct answers for the knowledge questions on iron and zinc and knowledge scores prior to and following the food-based nutrition intervention | | | | | | | | | |
| Questions within categories | |  | Pre  %(n) | Post  %(n) | | ꭕ2 | | P1 | |
| Which is not a benefit of soaking? | | Intervention  Comparison | 23.6(13)  17.0(10) | 52.7(29)  13.6(8) | | 9.9  0.3 | | 0.002  0.60 | |
| Which method is most likely to preserve iron and zinc in maize and beans? | | Intervention  Comparison | 47.3(26)  25.42(15) | 90.9(50)  28.8(17) | | 24.5  0.2 | | 0.0001  0.68 | |
|  | | **Pre-Mean (± SD)** | **Post Mean (± SD)** | | **Difference Mean (± SD)** | | **S** | | **P2** |
| Iron and zinc scores | Intervention  Comparison | 0.35±0.36  0.21±0.30 | 0.72±0.32  0.21±0.28 | | - 0.36±0.45  0.00±0.39 | | -283  1.5 | | 0.0001  1.00 |

1Pearson chi-square

2Wilcoxon Signed Rank Test Paired Comparison

### 4.3.2 Pre-post Iron and Zinc Attitudes, Barriers and Scores in the Intervention and Comparison Groups

Table 7 describes the iron and zinc related attitudes in the intervention and comparison groups, pre- and post-intervention. Prior to the intervention, 45.5% of the intervention group indicated that it was “important” and “very important” to avoid taking tea with meals containing iron. The number increased significantly to 80% at p=0.0002 following the intervention. However, in the comparison group, 54.2% indicated that it was important to avoid tea with meals containing iron prior to the intervention, and there were no changes post-intervention (p=0.58). The proportion of participants who indicated that it was “important” and “very important” to soak maize and beans before cooking also increased significantly (p=0.009) from 54.6% to 78.2% in the intervention group, while there was a slight decline in the comparison group although, the difference was not significant. Further, there was a significant reduction (p=0.004) from 36.4% to 12.7% in the proportion of participants who felt that it was difficult to soak maize and beans in the intervention group while the comparison group remained similar at pre- and post-test. Overall, there was a significant improvement in the mean attitudes scores (- 0.22 ± 0.22; p= 0.0001) towards the recommended iron and zinc related practices following the intervention with no difference in the comparison group (- 0.04 ± 0.29; p = 0.27).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 7 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who described the recommendations concerning iron and zinc as “important/very important”, “difficult”, and iron and zinc attitude scores prior to and following the food-based nutrition education program. | | | | | | | | | | | |
| Response within category | | | | | Pre | Post | | ꭕ2 | | P1 | |
| *Important/very important* | |  | | | %(n) | %(n) | |  | |  | |
| Avoid tea when taking iron rich meals | | Intervention  Comparison | | | 45.5(25) 54.2(32) | 80.0(44) 49.2(29) | | 14.0  0.3 | | 0.0002  0.58 | |
| Soak maize and beans before cooking | | Intervention  Comparison | | | 54.6(30) 50.6(30) | 78.2(43) 39.0(23) | | 6.9  1.7 | | 0.009  0.20 | |
| *Difficult* | |  | | |  |  | |  | |  | |
| Soak maize and beans | | Intervention  Comparison | | | 36.4(20) 55.9(33) | 12.7(7) 44.1(33) | | 8.3  0.0 | | 0.004  1.00 | |
|  |  | | **Pre-Mean ± SD** | **Post-Mean ± SD** | | | **Mean Difference** | | **S** | | **P2** |
| Iron and zinc attitudes score | Intervention  Comparison | | 1.31±0.20  1.22±0.24 | 1.53±0.19  1.25±0.23 | | | - 0.22±0.22  - 0.04±0.29 | | -565.5  -115.5 | | 0.0001  0.27 |

1Pearson chi-square

2Wilcoxon Signed Rank Tests paired comparison.

#### 4.3.2.1 Pre-post Soaking Barriers and Scores in the Intervention and Comparison Groups

Prior to the intervention, two of the three barriers assessed, inadequate time and knowledge, were reported to be affecting >50% of the participants’ ability to soak maize and beans at home in both the intervention and comparison groups (Table 8). After the intervention, there was a significant decline from 63.6% to 45.4% at p=0.05 in the proportion of participants who perceived inadequate time as a barrier to soaking in the intervention group, while the comparison group remained similar at p=0.34. The proportion of participants who perceived inadequate knowledge on the benefits of soaking as a barrier also reduced from 61.8% to 30.9% at p=0.001 with no change in the comparison group (p=0.58). In addition, the proportion of participants who perceived inadequate water availability as a barrier to soaking also reduced from 25.4% to 12.7%. However, the difference was not significant (p= 0.09), and, in the comparison group, there was a slight increase from 28.8% to 37.3% in the proportion of participants who felt that inadequate water availability was a barrier to soaking although this was also not significant (p=0.33).

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| --- | --- | --- | --- | --- | --- |
| Table 8 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who reported on barriers to the practice of soaking maize and beans prior to and following the intervention | | | | | |
|  |  | Pre  %(n) | Post  %(n) | ꭕ2 | P |
| Inadequate time | Intervention  Comparison | 63.6(35)  66.1(39) | 45.4(25)  57.6(34) | 3.7  0.9 | 0.05  0.34 |
| Inadequate knowledge on benefits of soaking | Intervention  Comparison | 61.8(34)  50.8(30) | 30.9(17)  45.8(27) | 10.6  0.3 | 0.001  0.58 |
| Inadequate water availability | Intervention  Comparison | 25.4(14)  28.8(17) | 12.7(7)  37.3(22) | 2.9  1.0 | 0.09  0.33 |

1Pearson chi-square test

#### 4.3.2.2 Pre-post Fermentation Barriers and Scores in the Intervention and Comparison Groups

Table 9 describes the barriers to fermentation, pre- and post-intervention. Following the intervention, there was a significant reduction in the mean attitudes towards fermentation in the intervention group (- 0.14 ± 0.25; p=0.001) relative to the comparison group (- 0.02 ± 0.39 p=0.80). The proportion of participants who perceived inadequate knowledge as a barrier to fermentation reduced from 43.6% to 18.2% at p=0.003 in the intervention group, and from 39.0% to 32.2% in the comparison group; however, the difference in the comparison group was not significant at p=0.44. The proportion of participants who perceived water availability as a barrier also reduced significantly from 29.1% to 10.9% at p=0.01 in the intervention group, and contrarily, the comparison group remained similar at p=0.13. The proportion of participants who felt that the taste of fermented porridge was a limiting factor also reduced from 30.9% to 18.2%; p=0.12 with no change in the comparison group (p=0.85).

There was no change in the participants’ perception toward inadequate time as a barrier to fermentation in the intervention (p=1.00) and comparison groups (p=0.20).

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 9 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who reported barriers to the practice of fermenting porridge at their homes and fermentation attitude scores prior to and following the food-based nutrition intervention | | | | | | | | | | |
| Fermentation barriers | | | Pre  %(n) | | Post  %(n) | | ꭕ2 | | P1 | |
| Inadequate time | Intervention  Comparison | | 63.7(35)  45.8(27) | | 65.5(36)  59.3(35) | | 0.0  2.2 | | 1.00  0.20 | |
| Inadequate knowledge on benefits of fermentation | Intervention  Comparison | | 43.6(24)  39.0(23) | | 18.2(10)  32.2(19) | | 8.3  0.6 | | 0.003  0.44 | |
| Inadequate water availability | Intervention  Comparison | | 29.1(16)  16.9(10) | | 10.9(6)  28.8(17) | | 5.7  2.4 | | 0.01  0.13 | |
| Don’t like the taste | Intervention  Comparison | | 30.9(17)  45.8(28) | | 18.2(10)  47.5(27) | | 2.4  0.0 | | 0.12  0.85 | |
| Fermentation attitude score | **Pre**  **Mean ± SD** | | | **Post Mean ± SD** | | **Difference Mean ± SD** | | **S** | | **P2** |
| Intervention | | 0.65±0.32 | | 0.80±0.27 | | - 0.14±0.25 | | - 165.5 | | 0.001 |
| Comparison | | 0.61±0.32 | | 0.63±0.31 | | - 0.02±0.39 | | -21 | | 0.79 |

1Pearson chi-square test

2Paired comparison using Wilcoxon Signed Rank Tests

### 4.3.3 Pre-post Iron and Zinc Practices and Scores in the Intervention and Comparison Groups

Table 10 shows the proportion of participants who reported implementing the iron and zinc related practices in the intervention and comparison groups and the mean difference scores. Following the program, there was a significant mean increase of - 0.41 ± 0.91; p=0.002 in the average number of participants in the intervention group who reported on the iron and zinc related practices implemented “sometimes” and “always” at home relative to the comparison group that had a similar score at pre and post-tests (0.03 ± 0.60; p=0.52). The practice of fermenting porridge before cooking increased significantly (p=0.01) from 25.5% to 47.3%, “sometimes” in the intervention group relative to the comparison group (p=0.10). Also, despite a significant increase in the proportion of participants in the intervention group who reported soaking both maize and beans from 63.6% to 80.0% at p=0.002, the proportion of participants who reported soaking beans only also increased significantly from 27.3% to 47.3% at p=0.008, “always” and “25.5% to 34.6% “sometimes”. The proportion of participants who reported the soaking of maize only was also approaching significance; from 23.6% to 32.7%, “sometimes” and 36.4% to 43.6%, “always” at p=0.07. The differences in the comparison group were not significant.

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| Table 10 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who reported implementing iron and zinc related practices at their homes and practice scores prior to and following the food-based nutrition education intervention | | | | | | | | | | |
|  |  |  | Pre  %(n) | | Post  %(n) | | ꭕ2 | | P1 | |
| How often is porridge fermented at home | Intervention | Sometimes  Always | 25.5(14)  30.9(17) | | 47.3(26)  25.5(14) | | 11.0 | | 0.01 | |
| Comparison | Sometimes  Always | 50.9(30)  3.4(2) | | 35.6(21)  6.8(4) | | 6.2 | | 0.10 | |
| How often is maize soaked before cooking nyoyo | Intervention | Sometimes  Always | 23.6(13)  36.4(20) | | 32.7(18)  43.6(24) | | 7.2 | | 0.07 | |
| Comparison | Sometimes  Always | 20.3(12)  11.9(7) | | 17.0(10)  18.6(11) | | 1.6 | | 0.64 | |
| How often are beans soaked before cooking | Intervention | Sometimes  Always | 25.5(14)  27.3(15) | | 34.6(19)  47.3(26) | | 11.7 | | 0.008 | |
| Comparison | Sometimes  Always | 25.4(15)  17.0(10) | | 13.6(8)  18.6(11) | | 2.7 | | 0.45 | |
| Soak maize and beans at home | Intervention  Comparison | Yes  Yes | 63.6(35)  47.5(28) | | 80.0(44)  32.2(19) | | 3.6  3.6 | | 0.06  0.16 | |
| Question category scores |  | **Pre-Mean (±SD)** | | **Post Mean (±SD)** | | **Difference Mean (±SD)** | | **S** | | **P2** |
| Zinc and iron practices score | Intervention | 1.34±0.80 | | 1.75±0.59 | | - 0.41±0.91 | | - 302 | | 0.002 |
| Comparison | 0.94±0.68 | | 0.92±0.76 | | 0.03±0.60 | | 61.5 | | 0.52 |

1Pearson chi-square

2Wilcoxon Signed Rank Test paired comparison

## 4.4 Vitamin A and C Knowledge, Attitudes and Practices

4.4.1 Pre-post Vitamin A and C Knowledge and Scores in the Intervention and Comparison Groups

As shown in Table 11, there was a significant mean increase in the vitamin A and C related knowledge score in the intervention group (- 0.13 ± 0.28; p=0.004) relative to the comparison group (0.08 ± 0.38; p=0.13). The proportion of participants who selected nyoyo with added orange/yellow and green vegetables as the most nutritious increased from 38.2% to 67.3% at p=0.002 in the intervention group, while there was a significant decline (p=0.01) from 28.85% to 10.2% in the comparison group. There was no change in the proportion of participants who knew the correct answer for why green vegetables are cooked a short time in either group.

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| Table 11 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who had correct answers for the knowledge questions on vitamin A and C and knowledge scores prior to and following the food-based nutrition intervention | | | | | | | | | | |
| Questions within categories | |  | | | Pre  %(n) | Post  %(n) | | ꭕ2 | | P1 |
| Cook green vegetables for only 10-15 minutes to preserve nutrients? | | | Intervention  Comparison | | 72.73  71.19 | 70.91  74.58 | 0.04  0.17 | | | 0.83  0.68 |
| Which nyoyo composition has the highest nutrients? | | | Intervention  Comparison | | 38.2(21)  28.8(17) | 67.3(37)  10.2(6) | 9.33  6.5 | | | 0.002  0.01 |
|  | | **Pre-Mean (± SD)** | | **Post Mean (± SD)** | | **Difference Mean (± SD)** | | | **S** | **P2** |
| Vitamin A and C scores | Intervention  Comparison | 0.55±0.38  0.50±0.37 | | 0.69±0.39  0.42±0.29 | | - 0.13±0.28  0.08±0.38 | | | - 65  63 | 0.004  0.13 |

1Pearson chi-square test

2Paired comparison using Wilcoxon Signed Rank Tests

#### 4.4.1.1 Pre-post Nutrient Sources Knowledge Scores in the Intervention and Comparison Group

Table 12 shows results regarding knowledge of vitamin A, C, iron and zinc food sources. The knowledge of iron, zinc, β carotene and vitamin C sources, as indicated by the number who answered all three questions correct, was low among participants in both groups before the intervention: only 5.6% and 3.4% correctly matched the three food sources to their nutrients in the intervention and comparison groups respectively. Following the intervention, there was a four-fold increase from 5.6% to 21.8% (P=0.0001) noted in the proportion of participants who matched the nutrients with their correct food sources in the intervention group relative to the comparison group (from 3.4% to 11.9 %; p=0.07). There was a significant increase (p=0.02) from 9.1% to 25.5% in the proportion of participants who identified orange-fleshed sweet potatoes as sources of vitamin A in the intervention group, while the comparison remained similar in the pre and post-tests at 18.6% (p=1.00). Similarly, there was a significant increase from 7.3% to 21.8% (p=0.03) in the number of participants in the intervention group who also identified green leafy vegetables as sources of vitamin C relative to the comparison group (8.5% to 11.5%; p=0.54), with no significant difference in the proportion of participants who identified green-leafy vegetables as sources of vitamin A in either group. Further, the proportion of participants who identified maize and beans as sources of iron and zinc also increased from 38.2% to 87.3% at p=0.0001 in the intervention group with no change in the comparison group (p=0.35). Overall, there was a mean increase of - 0.17 ± 0.27; p=0.0001 in the average knowledge of nutrient sources of the intervention group relative to the comparison group (- 0.01 ± 0.23; p=0.87).

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| Table 12 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who had correct answers for the knowledge questions on iron, zinc, and vitamin A/C sources prior to and following the food-based nutrition intervention. | | | | | | | | | | |
| Nutrients sources | |  | Pre  %(n) | Post  %(n) | | ꭕ2 | | P1 | | |
| All questions correct | | Intervention  Comparison | 5.6(4) 3.4(2) | 21.8(24) 11.9(7) | | 28.9  7.1 | | 0.0001  0.07 | | |
| Green leafy vegetables as a source of vitamin A | | Intervention  Comparison | 78.2(43)  66.1(39) | 72.7(40) 74.6(44) | | 0.4  1.0 | | 0.51  0.31 | | |
| Orange-fleshed sweet potatoes as a source of vitamin A | | Intervention  Comparison | 9.1(5) 18.6(11) | 25.5(14)  18.6(11) | | 5.1  0.0 | | 0.02  1.00 | | |
| Green leafy vegetable as source of vitamin C | | Intervention  Comparison | 7.3(4) 8.5(5) | 21.8(12)  11.9(7) | | 4.7  0.4 | | 0.03  0.54 | | |
| Maize and beans as sources of iron and zinc | | Intervention  Comparison | 38.2(21)  49.2(29) | 87.3(48)  40.6(24) | | 28.3  0.9 | | 0.0001  0.35 | | |
| Nutrient sources knowledge score | **Pre-Mean (±SD )** | | **Post-Mean (±SD)** | | **Difference Mean (±SD)** | | **S** | | **P2** |
| Intervention  Comparison | 0.33±0.19 | | 0.53±0.16 | | - 0.17±0.27 | | -296 | | 0.0001 |
| 0.36±0.20 | | 0.36±0.20 | | - 0.01±0.23 | | -8 | | 0.87 |

1Pearson chi-square

2Wilcoxon Signed Rank Test paired comparison

4.4.2 Pre-post Vitamin A and C Attitudes and Scores in the Intervention and Comparison Groups

The analysis shown in Table 13 indicates a significant mean increase of - 0.09 ± 0.20; p=0.002 in the average vitamin A and C attitudes score in the intervention group relative to the comparison group; 0.03 ± 0.29 at p=0.19. There was an increase from 58.2% to 67.3% in the number of participants in the intervention group who reported that it was “important” and “very important” to add orange-fleshed vegetables to nyoyo during cooking, although the difference was not significant. However, in the comparison group, there was a significant decline from 49.2% to 28.8% at p=0.02 in the number of participants who reported that it was “important” and “very important” to add orange-fleshed vegetables to nyoyo during cooking. A similar trend was observed in the addition of green leafy vegetables to nyoyo where, there was an increase from 60.0% to 74.6% in the number of participants who reported the addition of green leafy vegetables to nyoyo during cooking in the intervention group and a decline from 64.4% to 54.2% in the comparison group; the differences did not reach statistical significance in the intervention and comparison groups p=0.10 and p=0.26 respectively. Fewer participants in the intervention group also felt that it was difficult to add orange-fleshed and green leafy vegetables to nyoyo during cooking than in the comparison group following the intervention.

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| Table 13 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who felt it was “important /very important” and “difficult” to implement vitamin A and C related practices prior to and following the food-based nutrition education intervention. | | | | | | | | | | |
|  | | | | Pre | Post | | ꭕ2 | | P1 | |
| *Important/very important* | | | | %(n) | %(n) | |  | |  | |
| Add orange /yellow fleshed vegetable to nyoyo during cooking | | | Intervention  Comparison | 58.2(32) 49.2(29) | 67.3(37) 28.8(17) | | 1.0  5.1 | | 0.32  0.02 | |
| Add green vegetables to nyoyo during cooking | | | Intervention  Comparison | 60.0(33) 64.4(38) | 74.6(41) 54.2(32) | | 2.6  1.3 | | 0.10  0.26 | |
| *Difficult* | | |  |  |  | |  | |  | |
| Add orange-fleshed vegetables to nyoyo | | | Intervention  Comparison | 40.0(22)  84.8(50) | 38.2(21) 74.6(44) | | 0.0  1.9 | | 0.85  0.17 | |
| Add green vegetables to nyoyo | | | Intervention  Comparison | 36.4(20) 69.5(41) | 25.4(14) 52.5(31) | | 1.5  3.6 | | 0.22  0.06 | |
| Vitamin A and C score |  | **Pre-Mean ± SD** | | **Post-Mean ± SD** | | **Mean Difference ± SD** | | **S** | | **P2** |
|  | Intervention  Comparison | 1.39±0.19 | | 1.45±0.19 | | - 0.09±0.20 | | - 190 | | 0.002 |
| 1.09±0.21 | | 1.06±0.26 | | 0.03±0.29 | | 109 | | 0.19 |

1Pearson chi-square

2Wilcoxon Signed Rank Tests paired comparison

4.4.3 Pre-post Vitamin A and C Practices and Scores in the Intervention and Comparison Groups

Table 14 shows the proportion of participants who reported on vitamin A and C related practices implemented at their homes. Following the intervention there was a significant increase of - 0.17 ± 0.33; p=0.0001 in the mean practices score of the intervention group relative to the comparison group - 0.06 ± 0.18; p=0.03. The proportion of participants who reported adding green leafy vegetables to nyoyo during cooking increased from 29.1% to 47.3% at p=0.05 in the intervention group, while the comparison group remained similar at p=0.38. The proportion of participants who reported that green leafy vegetables were cooked for 10-15 minutes “always” also increased in both groups: a significant increase from 40.0% to 65.5% at p=0.008 in the intervention group and an increase from 6.8% to 20.3% in the comparison group that did not reach statistical significance (p=0.09).

The proportion of participants who reported the addition of orange /yellow-fleshed vegetables to nyoyo “always” also increased significantly (p=0.0002) from 5.5% to 23.6% in the intervention group with no change in the comparison group (p=0.49). There were no significant differences in the addition of specific orange-fleshed vegetables (carrots, pumpkin, and orange-fleshed sweet potatoes) to nyoyo in either of the groups following the intervention; however, the proportion of participants who reported that carrots, pumpkins and orange-fleshed sweet potatoes were added to nyoyo increased more in the intervention group than in the comparison group; carrots (27.3% to 41.8% vs 1.7% to 5.1%), pumpkin (14.6% to 25.5% vs 1.7 to 5.1%) and orange-fleshed sweet potatoes (5.5% to 12.7% vs 11.9 to 18.6%).

The use of cooking oil was high in both the intervention and comparison groups prior to the intervention. Almost all the participants reported cooking nyoyo with oil (>80%) prior to the study, which increased in the two groups; however, the increase in the intervention group was higher than in the comparison group, although the differences were not significant (p=0.30; p=0.79).

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| Table 14 : Proportion of participants in the intervention (n=55) and comparison (n=59) groups who reported the addition of vitamin A and C rich foods to nyoyo during preparation at home prior to and following the food-based nutrition education intervention | | | | | | | | |
|  | |  | | Pre  %(n) | Post  %(n) | ꭕ2 | | P1 |
| Always cook green vegetables for 10-15 minutes. | | Intervention  Comparison | | 40.0(22)  6.8(4) | 65.5(36) 20.3(12) | 9.5  4.7 | | 0.008  0.09 |
| Add green leafy vegetables to nyoyo | | Intervention  Comparison | | 29.1(16)  8.5(5) | 47.3(26)  13.6(8) | 3.9  0.8 | | 0.05  0.38 |
| Always add orange/yellow-fleshed vegetables to nyoyo when cooking | | Intervention  Comparison | | 5.5(3)  0.0(0) | 23.6(13)  3.4(2) | 11.0  2.6 | | 0.0002  0.49 |
| Add pumpkin to nyoyo | | Intervention  Comparison | | 14.6(8)  1.7(1) | 25.5(14)  5.1(3) | 2.0  1.0 | | 0.15  0.32 |
| Add orange-fleshed sweet potatoes to nyoyo | | Intervention  Comparison | | 5.5(3)  1.7(1) | 12.7(7)  5.1(3) | 1.8  1.0 | | 0.18  0.31 |
| Add carrots to nyoyo when cooking at home | | Intervention  Comparison | | 27.3(15)  11.9(7) | 41.8(23)  18.6(11) | 2.6  1.0 | | 0.11  0.31 |
| Use cooking oil when preparing nyoyo | | Intervention  Comparison | | 89.1(49)  84.8(50) | 94.6(52)  86.4(51) | 1.1  0.1 | | 0.30  0.79 |
|  |  | **Pre Mean (±SD)** | **Post**  **Mean (±SD)** | | **Difference Mean (±SD)** | | **S** | **P2** |
| Vitamin A and C practices scores | Intervention | 0.45±0.25 | 0.63±0.23 | | - 0.17±0.33 | | -359.5 | 0.0001 |
| Comparison | 0.31±0.20 | 0.37±0.17 | | - 0.06±0.18 | | -125 | 0.03 |

1Pearson chi-square

2Wilcoxon Signed Rank Test paired comparison

## 4.5 Kitchen Garden Knowledge, Attitudes and Practices

The knowledge and attitudes towards kitchen gardening are described in Table 15.

### 4.5.1 Pre-post Kitchen Gardening Knowledge in the Intervention and Comparison Groups

Following the intervention there was a significant increase from 73.6% to 90.9% in the proportion of participants in the intervention group who defined kitchen gardening correctly (p=0.04) whereas, in the comparison, knowledge on kitchen gardening remained similar at 66.1%; p=1.00 in the comparison group.

4.5.2 Pre-post Kitchen Gardening Attitudes and Scores in the Intervention and Comparison Groups

Over the course of the study, there was a significant mean increase of - 0.17 ± 0.36; p=0.001 in the attitudes scores of the intervention group relative to the comparison group, - 0.07 ± 0.42; p=0.22. The proportion of participants in the intervention group who felt that it was “important” and “very important” to have a kitchen garden at home increased from 60% to 83.6% at p=0.01 relative to the comparison group that had no significant difference (p=0.69). Nevertheless, the proportion of the participants who felt it was “difficult” to practice kitchen gardening decreased in both the intervention and comparison groups, although the differences were not significant, p=0.18 and p=0.06, respectively.

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| Table 15 : The proportion of participants who defined kitchen gardening correctly and felt that it was “important” and “difficult” to have a kitchen garden | | | | | | | |
|  | |  | | Pre  %(n) | Post  %(n) | S | P1 |
| *Kitchen garden knowledge* | |  | |  |  |  |  |
| Define kitchen gardening | | Intervention  Comparison | | 76.3(42)  66.1(39) | 90.9(50)  66.1(39) | 4.3  0.0 | 0.04  1.00 |
| *Kitchen garden attitudes and perceived barrier* | |  | |  |  |  |  |
| Important to have a kitchen garden | | Intervention  Comparison | | 60.0(33) 71.2(42) | 83.6(46) 67.8(40) | 7.6  0.2 | 0.01  0.69 |
| Difficult to establish and maintain a kitchen garden | | Intervention  Comparison | | 29.1(16) 54.2(32) | 18.2(10) 37.3(22) | 1.8  3.4 | 0.18  0.06 |
|  |  | | **Pre Mean ± SD** | **Post Mean ± SD** | **Mean Difference ± SD** | **S** | **P2** |
| Kitchen gardening attitude score | Intervention | | 1.65±0.37 | 1.83±0.29 | - 0.17±0.36 | -79.0 | 0.001 |
| Comparison | | 1.58±0.31 | 1.65±0.34 | - 0.07±0.42 | - 62.5 | 0.22 |

1Pearson chi-square

2 Wilcoxon Signed Rank Tests paired comparison

### 4.5.3 Pre-post Kitchen Gardening/Farming Practices and Scores in the Intervention and Comparison Groups

Table 16 shows some of the food crops grown and animals reared in the participants’ household farms during the study period. In the intervention and comparison groups, the most commonly grown food and field crops were pumpkin, > 75%,beans, > 60%, animal sources of meat and milk, > 50% and maize, > 90%. Different varieties of green leafy vegetables were also moderately grown, with the most dominant being kales, > 60%.

Orange-fleshed vegetables, carrots and orange-fleshed sweet potatoes and other vegetables, such as capsicum and tomatoes were the least grown food crops in the intervention and comparison groups. Following the intervention, capsicum production increased significantly from 10.9% to 41.8%; p=0.0004. There was also an increase in carrot production from 3.6% to 14.6%, although the differences were not significant (p=0.08) in the intervention group post-intervention. In the comparison group, there was no significant change in the crops grown over the study period. There was no significant change in the production of the remaining crops over the study period.

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| Table 16 : Proportion of participants reporting that crops were grown at their homes during the study period | | | | | | | |
|  | Intervention  (n=55)  % | | | Comparison  (n=59)  % | | | |
|  | Pre-test | Post-test | P1 | Pre-test | Post-test | P1 |
| Carrots | 3.6 | 14.6 | 0.08 | 1.7 | 1.7 | 0.60 |
| Pumpkin | 78. | 78.2 | 0.59 | 78.0 | 69.5 | 0.40 |
| Orange-fleshed sweet potatoes | 18.2 | 18.2 | 0.49 | 8.5 | 8.5 | 1.00 |
| Amaranth | 61.8 | 69.1 | 0.42 | 76.3 | 61.0 | 0.09 |
| Black night shade | 81.8 | 54.6 | 0.003 | 67.8 | 55.9 | 0.18 |
| Tomatoes | 27.3 | 9.1 | 0.01 | 22.0 | 15.3 | 0.64 |
| Spinach | 27.3 | 27.3 | 0.60 | 13.6 | 10.2 | 0.73 |
| Sukuma wiki | 74.6 | 83.6 | 0.37 | 64.4 | 76.3 | 0.26 |
| Capsicum | 10.9 | 41.8 | 0.0004 | 8.5 | 6.8 | 0.73 |
| Maize | 98.2 | 92.7 | 0.17 | 94.9 | 91.5 | 0.46 |
| Beans | 96.4 | 78.2 | 0.004 | 61.0 | 71.1 | 0.26 |
| Meat | 54.6 | 50.2 | 0.81 | 72.9 | 61.0 | 0.28 |
| Milk | 45.5 | 54.6 | 0.63 | 57.6 | 50.8 | 0.46 |

1Pearson chi-square

## 4.6 Other Food Preparation Practices

### 4.6.1 Pre-post Food Preparation Practices and Scores in the Intervention and Comparison Groups

Figures 6 and 7 describe the proportion of participants who were involved in cooking at home and their frequency of involvement in cooking. There was no significant change in participants’ involvement in meal preparation over the study. However, the frequency of cooking among those involved in meal preparation was higher in the comparison group than in the intervention group. In the post - interventions comparisons, the intervention group also had a higher proportion (40%) of participants who reported cooking “always” and “sometimes” than participants in the comparison group (32.2%).

Figure 8 and 9 describe the frequency of participants’ involvement in cooking various meals at home. Nyoyo, beans, porridge, and green leafy vegetables are some of the food sources of vitamin A, C, iron, and zinc participants learned about during the food-based nutrition education intervention.

The majority of the participants were involved in cooking at home: 100% and >95% in the intervention and comparison groups respectively. However, their involvement in cooking the foods assessed was generally low (>40%) according to pre- and post-intervention data. There was no significant increase in their involvement in cooking over the study.

Participants reported having cooked mostly tea, vegetables and porridge during the study period. None of the participants in the intervention group reported preparing nyoyo at home, and <5% prepared beans in both the intervention and comparison groups.

Figure . Proportion of Children Who Were Involved in Food Preparation at Home

Figure . Proportion of Children Who Cooked “Always” and “Sometimes” at Home

Figure . Proportion of Participants in the Intervention Group (n=55) who Cooked Different Foods at Home during the Study Period

Figure . Proportion of Participants in the Comparison Intervention (n=59) Group who Cooked Different Foods at Home During the Study Period

## 4.7 Food Consumption

### 4.7.1 Pre-post Food Consumption Frequencies in the Intervention and Comparison Groups

Tables 17, 18, 19, and 20 describe the participants’ food consumption frequencies during the study period. The consumption frequencies were expressed as “often” (four to six times/daily in a week), “sometimes” (two to three times in a week) and “none” (ones or never in a week).

Over the study, the consumption of cereals ‘often’ remained similar at pre and post-tests. Prior to the intervention, > 80% of the participants consumed maize, > 50% wheat, >30% sorghum and cassava and >20% millet.

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| Table 17 : Frequencies of foods (cereals and nuts) consumed by participants in the intervention (n=55) and comparison (n=59) groups prior to and following the intervention | | | | | | | | | | |
|  |  |  | Intervention group | | | | Comparison group | | | |
|  |  |  | **None** (0-1/wk) | **Sometimes** (2-3/wk ) | **Often** (4-6/ wk) | **P** | **None**  (0-1/wk) | **Sometimes**  (2-3/wk) | **Often** (4-6/wk) | **P** |
| Cereals | Maize | Pre-test | 1.8 | 14.6 | 83.6 | 0.60 | 0 | 5.1 | 94.9 | 0.09 |
|  | Post-test | 0.0 | 14.6 | 85.4 |  | 3.4 | 13.6 | 83.1 |  |
| Sorghum | Pre-test | 47.3 | 16.4 | 36.4 | 0.85 | 27.1 | 22.0 | 50.9 | 0.12 |
|  | Post-test | 41.8 | 18.2 | 40.0 |  | 35.6 | 32.2 | 32.2 |  |
| Millet | Pre-test | 58.2 | 18.2 | 23.6 | 0.39 | 57.6 | 15.3 | 27.1 | 0.24 |
|  | Post-test | 62.9 | 9.3 | 27.8 |  | 62.7 | 22.0 | 15.3 |  |
| Cassava | Pre-test | 40.0 | 23.6 | 36.4 | 0.67 | 35.6 | 32.2 | 32.2 | 0.29 |
|  | Post-test | 34.6 | 30.9 | 34.6 |  | 23.7 | 44.1 | 32.2 |  |
| Wheat | Pre-test | 9.1 | 40.0 | 50.9 | 0.07 | 6.8 | 37.3 | 55.9 | 0.47 |
|  | Post-test | 0.0 | 40.0 | 60.0 |  | 13.6 | 33.9 | 52.4 |  |
| Nuts | Groundnut | Pre-test | 12.7 | 27.3 | 60.0 | 0.07 | 23.7 | 30.5 | 45.8 | 0.08 |
|  | Post-test | 29.1 | 29.1 | 41.8 |  | 39.0 | 33.9 | 27.1 |  |

The consumption of green leafy and other vegetables did not change over the study. Kales was consumed most in the intervention and comparison groups with an increase in consumption from 67.3% to 74.6% in the intervention group at 0.07 and 50.9% to 59.3% at p=0.65 in the comparison group. On the other hand, spinach was the least consumed in the intervention and comparison groups prior to the study, with a decline in the consumption frequency of the intervention group from 14.6% to 9.1% at p=0.35 and a slight increase from 3.4% to 6.8% at p=0.53 in the comparison group, post-intervention. The differences were not significant. The other green leafy vegetables (kales, jute mallow, black nightshade, and spider plant) were moderately consumed, and this remained similar over the study period.

The consumption ofother vegetables, onions and tomatoes were also high prior to and following the intervention; > 80 % of the participants consumed onions in the intervention and comparison groups prior to the study, which remained similar at p=1.00 and p=0.58 respectively post-intervention. Similarly, >80% consumed tomatoes in the intervention and comparison groups prior to the study, and there was a slight increase and a decline in the intervention and comparison groups, respectively; however, the differences were not significant post-intervention, p=0.21 and p=0.45. Capsicum consumption remained low over the study period, < 20% in both groups.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 18 : Frequencies of foods (green leafy and other vegetables) consumed by participants in the intervention (n=55) and comparison (n=59) groups prior to and following the intervention | | | | | | | | | | |
|  |  |  | Intervention | | | | Comparison | | | |
|  |  |  | **None** | **Sometimes** | **Often** | **P** | **None** | **Sometimes** | **Often** | **P** |
| Green leafy vegetables | Kunde | Pre-test | 47.3 | 27.3 | 25.5 | 0.42 | 42.4 | 32.2 | 25.4 | 0.83 |
|  | Post-test | 43.6 | 38.2 | 18.2 |  | 40.7 | 37.3 | 22.0 |  |
| Kales | Pre-test | 9.1 | 23.6 | 67.3 | 0.07 | 6.8 | 42.4 | 50.9 | 0.65 |
|  | Post-test | 0.0 | 25.5 | 74.6 |  | 5.08 | 35.6 | 59.3 |  |
| Jute | Pre-test | 30.9 | 36.4 | 32.7 | 0.69 | 25.4 | 40.7 | 33.9 | 0.42 |
|  | Post-test | 23.6 | 40.0 | 36.4 |  | 25.4 | 50.9 | 23.7 |  |
| Spinach | Pre-test | 74.6 | 10.9 | 14.6 | 0.35 | 81.4 | 15.3 | 3.4 | 0.53 |
|  | Post-test | 85.5 | 5.5 | 9.1 |  | 83.1 | 10.2 | 6.8 |  |
| Spider plant | Pre-test | 45.5 | 30.9 | 23.6 | 0.78 | 55.9 | 28.8 | 15.3 | 0.83 |
|  | Post-test | 40.0 | 30.9 | 29.1 |  | 52.5 | 33.9 | 13.6 |  |
| Amaranth | Pre-test | 49.1 | 18.2 | 32.7 | 0.47 | 52.5 | 23.7 | 23.5 | 0.07 |
|  | Post-test | 47.3 | 27.3 | 25.5 |  | 61.0 | 30.5 | 8.5 |  |
| Black night shade | Pre-test | 27.3 | 38.2 | 34.6 | 0.39 | 37.3 | 30.5 | 32.2 | 0.47 |
|  | Post-test | 36.4 | 40.0 | 23.6 |  | 47.5 | 28.8 | 23.7 |  |
| Pumpkin leaves | Pre-test |  | 40.5 | 59.5 | 1.00 |  | 56.3 | 43.8 | 0.18 |
|  | Post-test | - | 40.5 | 59.5 |  | - | 70.0 | 30.0 |  |
| Other vegetables | Onions | Pre-test | 1.8 | 1.8 | 96.4 | 0.51 | 6.8 | 10.2 | 83.1 | 0.53 |
|  | Post-test | 0.0 | 3.6 | 96.4 |  | 3.4 | 15.3 | 81.1 |  |
| Tomatoes | Pre-test | 5.5 | 5.5 | 89.1 | 0.21 | 5.1 | 11.9 | 83.1 | 0.45 |
|  | Post-test | 5.5 | 0.0 | 94.6 |  | 5.08 | 20.3 | 74.6 |  |
| Capsicum | Pre-test | 69.1 | 12.7 | 18.2 | 0.22 | 72.9 | 13.6 | 13.6 | 0.12 |
|  | Post-test | 56.4 | 25.5 | 18.2 |  | 84.8 | 11.9 | 3.4 |  |

While the consumption of fruits was generally low in the intervention and comparison groups, the proportion of participants who consumed mangoes “often” in the intervention group were higher than the comparison group (64.8% vs 25.4%); however, following the intervention, the proportion of the intervention group who consumed mangoes “often”, decreased more in the intervention than the intervention group, from 68.8% to 21.8% at p=0.001 and 25.4% to 18.6% at p=0.17 in the comparison group. The consumption frequency of mangoes in the comparison group remained similar at pre- and post-tests. The consumption of all orange-fleshed vegetables was also generally low at <20% and remained similar post-intervention.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 19 : Frequencies of foods (fruits and orange-fleshed vegetables) consumed by participants in the intervention (n=55) and comparison (n=59) groups prior to and following the intervention | | | | | | | | | | |
|  |  |  | **Intervention group** | | | | **Comparison group** | | | |
|  |  |  | **None** | **Sometimes** | **Often** | **p** | **None** | **Sometimes** | **Often** | **P** |
| Fruits | Mangoes | Pre-test | 13.0 | 22.2 | 64.8 | 0.0001 | 32.2 | 42.4 | 25.4 | 0.17 |
|  | Post-test | 45.5 | 32.7 | 21.8 |  | 49.2 | 32.2 | 18.6 |  |
| Watermelon | Pre-test | 76.0 | 24.0 | 0.0 | 0.05 | 80.4 | 17.9 | 1.8 | 0.71 |
|  | Post-test | 87.3 | 9.1 | 3.6 |  | 86.0 | 12.3 | 1.8 |  |
| Bananas | Pre-test | 54.6 | 14.6 | 30.9 | 0.005 | 39.2 | 37.3 | 23.7 | 0.64 |
|  | Post-test | 27.3 | 36.4 | 36.4 |  | 44.1 | 39.0 | 17.0 |  |
| Oranges | Pre-test | 29.1 | 40.0 | 30.9 | 0.92 | 33.9 | 42.4 | 23.7 | 0.79 |
|  | Post-test | 30.9 | 41.8 | 27.3 |  | 30.5 | 49.2 | 20.3 |  |
| Paw paw | Pre-test | 30.9 | 29.1 | 40.0 | 0.83 | 35.6 | 35.6 | 28.8 | 0.43 |
|  | Post-test | 34.6 | 30.9 | 34.6 |  | 47.5 | 28.1 | 23.7 |  |
| Orange fleshed vegetables | Butternut | Pre-test | 85.5 | 10.9 | 3.6 | 0.48 | 78.0 | 11.9 | 10.2 | 0.06 |
|  | Post-test | 76.4 | 18.2 | 5.5 |  | 93.2 | 3.4 | 3.4 |  |
| Pumpkin | Pre-test | 56.4 | 23.6 | 20.0 | 0.45 | 39.0 | 45.8 | 15.3 | 0.12 |
|  | Post-test | 47.3 | 34.6 | 18.2 |  | 57.6 | 30.5 | 11.9 |  |
| Orange-fleshed sweet potatoes | Pre-test | 70.9 | 20.0 | 9.1 | 0.50 | 72.9 | 18.6 | 8.5 | 0.02 |
|  | Post-test | 74.6 | 21.8 | 3.64 |  | 89.8 | 10.2 | 0.0 |  |
| Carrots | Pre-test | 72.7 | 12.7 | 14.6 | 0.45 | 76.3 | 17.0 | 6.8 | 0.34 |
|  | Post-test | 65.5 | 21.8 | 12.7 |  | 86.4 | 8.5 | 5.1 |  |

There were no statistically significant differences in the consumption of plant and animal sources of protein in the intervention and comparison groups. Prior to the intervention, the proportion of participants who reported consuming green grams “often” were higher in the intervention than the comparison group (23.6 % vs 15.3%); the consumption further declined post-intervention, although the differences were not significant. Consumption of beans had a similar trend.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 20 : Frequencies of foods (plant and animal proteins) consumed by participants in the intervention (n=55) and comparison (n=59) groups prior to and following the intervention | | | | | | | | | | |
|  |  |  | **Intervention group** | | | | **Comparison group** | | | |
|  |  |  | **None** | **Sometimes** | **Often** | **P** | **None** | **Sometimes** | **Often** | **P** |
| Plant proteins | Green grams | Pre-test | 40.0 | 36.4 | 23.6 | 0.21 | 57.6 | 27.1 | 15.3 | **0.61** |
|  | Post-test | 56.4 | 29.1 | 14.6 |  | 66.1 | 20.3 | 13.6 |  |
| Beans | Pre-test | 23.6 | 47.3 | 29.1 | 0.13 | 27.1 | 57.6 | 15.3 | **0.61** |
|  |  | Post-test | 10.9 | 63.6 | 25.5 |  | 35.6 | 50.9 | 13.6 |  |
| Animal proteins | Meat | Pre-test | 47.3 | 41.8 | 10.9 | 0.78 | 52.5 | 30.5 | 17.0 | **0.36** |
|  | Post-test | 41.8 | 43.6 | 14.6 |  | 61.9 | 30.5 | 8.5 |  |
| Chicken | Pre-test | 56.4 | 30.9 | 12.7 | 0.09 | 55.9 | 32.2 | 11.9 | **0.01** |
|  | Post-test | 65.5 | 32.7 | 1.8 |  | 81.4 | 13.6 | 5.1 |  |
| Milk | Pre-test | 16.4 | 14.6 | 69.1 | 0.46 | 13.6 | 37.3 | 49.2 | **0.08** |
|  | Post-test | 16.4 | 23.6 | 60.0 |  | 30.5 | 32.2 | 37.3 |  |
| Eggs | Pre-test | 36.4 | 36.9 | 32.7 | 0.56 | 45.8 | 30.5 | 23.7 | **0.50** |
|  | Post-test | 40.0 | 36.4 | 23.6 |  | 49.2 | 35.6 | 15.3 |  |

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# Chapter 5.0: Discussion

This chapter presents discussions of the findings presented in Chapter 4 on the effects of a food-based nutrition education program on children’s knowledge, attitudes and practices, especially findings related to increasing the frequency of handwashing and other sanitation measures, increasing the availability and intake of foods containing β-carotene, vitamin C, iron and zinc and the use of kitchen gardens containing produce high in the micronutrients of interest.

## 5.1 Handwashing and Sanitation Knowledge, Attitudes and Practices

Intestinal worm infestation is one of the causes of micronutrient malnutrition, and a major public health concern thought to be associated with poor handwashing and sanitation knowledge, attitudes and practices (Food and Agricultural Organization, (FAO), 2017). Over the years, the Ministry of Education and Health, Kenya, have implemented various mitigation strategies such as having sanitation and hygiene as part of the curriculum at the early childhood education level as well as in grade school (Republic of Kenya (MoE), 2019). It is with this background that we included messages regarding handwashing in our program.

Generally, participants in both groups were highly aware that handwashing prevents the spread of germs; however, their knowledge of the correct handwashing procedure was low prior to the study. This finding is similar to the finding of a cross-sectional study conducted on Ghanaian school children that indicated high levels of knowledge about the importance of handwashing despite 53% of the participants reporting that they had never been taught about handwashing at school. It was noted that participants had poor handwashing practices with very few participants reporting that they washed their hands with soap before eating, after visiting the toilet, and after garbage collection at school, reflecting low knowledge of correct handwashing procedures (Dajaan et al., 2018). In our study, the knowledge of the importance of handwashing was high and there was also a significant increase in the knowledge of correct handwashing in terms of the definition and recommended procedure in both the intervention and comparison groups following the program. These findings could be attributed to the high countrywide sensitization by the Kenyan Ministry of Health regarding handwashing as a means of preventing transmission of COVID 19 (Republic of Kenya (MoE), 2020; Republic of Kenya (MoH), 2020). We found that more than 95% of the participants in both groups were aware that regular handwashing prevents the spread of germs following the study. This finding is consistent with the findings of cross-sectional studies conducted with school children in Ghana and Nepal, where all participants reported being knowledgeable on handwashing (Dajaan et al., 2018; Manandhar & Chandyo, 2018). Similarly, a study in India indicated a significant increase in knowledge of the correct handwashing procedures from 0% to 35% following a two-month handwashing education intervention (Shrestha & Angolkar, 2015). In contrast, an Ethiopian cross-sectional survey indicated low knowledge of handwashing among school children; only 52% and 14.8% were knowledgeable on the importance and correct handwashing procedures, respectively (Vivas et al., 2010).

Following the intervention, the attitude score for sanitation and handwashing increased significantly in the intervention group while the comparison group was unchanged. This suggests that participants in the current study were impacted positively by the intervention since COVID 19 preventive education was offered by teachers in schools concurrently with our intervention. This finding is similar to findings of a cross-sectional study conducted with primary school children in Ethiopia, where three-quarters of the children had positive attitudes towards handwashing (Eshetu et al., 2020). In the present study, a higher proportion of participants not only perceived regular handwashing as important prior to the intervention, but a marked increase was also observed in the intervention group post-intervention. The number of participants who felt that deworming practice was important also increased in the intervention group post-intervention, although this was not significant. This finding is similar to the finding of a mid-term evaluation of a five-year school-based deworming program conducted with school children of grades 2-6 in 200 schools in Kenya which found that deworming is very effective in reducing soil-transmitted helminths (STH). This school-based deworming involved the analysis STH egg counts in school children’s stool samples which reduced following the deworming intervention (Okoyo et al., 2016).

With regards to practices, there was a significant increase in the mean handwashing practices score of the intervention group relative to the comparison group. This could be attributed to the fact that, despite the participants in both groups having received information on handwashing at the same time, the intervention group acquired new additional knowledge from the intervention about handwashing than the comparison group. This finding is similar to the findings from a three-month pre-post cross-sectional handwashing study among pupils in Ghana, where the overall handwashing practice increased significantly from 9% to 23% following a handwashing intervention (Kweku et al., 2018). Likewise, a study in India noted a significant increase in handwashing practice following a handwashing education intervention (Shrestha & Angolkar, 2015). In our study, there was a significant increase in the number of participants who reported that they washed their hands after changing baby diapers and before preparing food. In addition, a higher proportion of the intervention group reported that they washed their hands before eating relative to the comparison group following the intervention, although the increase was not statistically significant. This finding is similar to the finding of the Ghanaian study, where there was no change in the proportion of participants who reported washing their hands before eating following a handwashing intervention (Kweku et al., 2018). However, it is slightly lower than the findings of a Kenyan cross-sectional study where 94% of the school children indicated that they washed their hands before eating and before handling food (Nyapera, 2021). In our study, even though almost half of the participants reported washing their hands after visiting the toilet, there was no significant improvement over the study. This finding was slightly higher than the finding of a cross-sectional study in Ghana where only 40% reported that they always washed their hands after using the toilet (Dajaan et al., 2018). However, it differs from the findings of another Ghanaian study, where the authors found a significant increase in reported handwashing after visiting the toilet from 69% to 83% (Kweku et al., 2018). Likewise, in a Kenyan study, 93% of the school children indicated that they washed their hands after visiting the toilet (Nyapera, 2021). In our study, despite the presence of handwashing facilities such as leaky tins (small buckets or containers with holes that release water slowly for handwashing) (Esrich, 2020; Kweku et al., 2018) observed in the schools, water shortages were evident in some schools, where pupils would carry water to school every morning to fill the handwashing facilities. Our nutrition education project did not supply water for all students throughout the day; therefore, the practice of handwashing was not adhered to consistently. In other studies, hand washing facilities were also found to be inadequate as most of the schools lacked clean running water, soap and towels/paper tissues for hand washing (Dajaan et al., 2018; Kweku et al., 2018; Nyapera, 2021). This reinforces the importance of providing adequate resources (latrines, handwashing facilities, soap and safe water supply) in addition to increasing knowledge and improving attitudes about handwashing; all are necessary for behaviour change to occur (Kisaakye et al., 2021). Nevertheless, the practical learning about handwashing during the education sessions and the additional knowledge from the curriculum likely increased the proportion of participants in the present study with positive attitudes regarding the importance of washing hands regularly. These likely resulted in a significant improvement in handwashing at the recommended critical times post-intervention in the intervention group.

## 5.2 Zinc and Iron Knowledge, Attitudes and Practices

The food-based nutrition education program in this study focused on teaching children the nutritional value of maize and beans, and the importance of soaking and fermentation as recommended practices that would preserve and ensure maximum utilization of iron, zinc and other nutrients in maize and beans. Barriers to implementing these practices were discussed/described as part of the curriculum, along with ways to reduce the barriers.

Prior to the intervention, participants in intervention and comparison groups had little knowledge of soaking maize and beans and its benefits. This could be attributed to the fact that primary school children in this region had not been exposed to food-based learning that involves the soaking of pulses and legumes. Moreover, much of the nutrition education for Kenyan school children takes place in schools, the science curriculum providing knowledge of the basics of nutrition education with limited food-based or practical lessons. For instance, lessons taught in grade 4 about legumes, cereals and seeds focus on their definitions and their classification as food crops but do not provide any experiential learning opportunities (Republic of Kenya (MoE), 2019; Mwangi et al., 2019). Following the intervention there was a two-fold increase in the number of participants in the intervention group who identified soaking and its benefits of preserving iron and zinc in maize and beans, while there was no change in the comparison group. These findings are similar to those of a six-month Ethiopian pulse-based study conducted with children of 10-14 years and their mothers which found a significant increase in knowledge of soaking and the benefits of this practice (Dargie et al., 2018). Likewise, our findings are consistent with a study conducted with women in Meru, Kenya, where ˃80% identified soaking as a practice that preserves iron and zinc in maize and beans.

Prior to the study, a small percentage (<50%) of the participants in both groups felt that the recommended iron and zinc practices were important. This could be attributed to their low frequency of involvement in cooking and lack of previous exposure to food-based nutrition education that promoted soaking. Following the intervention there was a significant improvement in the mean attitude score regarding the iron and zinc-related practices in the intervention group relative to the comparison group, suggesting that the intervention was effective. These findings are similar to the findings of studies conducted in Kenya and Ethiopia, where the participants' attitudes towards soaking maize beans improved significantly post-intervention (Dargie et al., 2018; Muthee, 2018). In this study, the significant improvement in attitudes towards soaking maize and beans and limiting tea intake at mealtimes may be linked to children’s increased knowledge of the rationale behind the practices taught during the food-based nutrition education program. Further, it could be attributed to the associated health benefits of soaking that were taught, including less flatulence and gastrointestinal problems. A clinical study conducted on gastroesophageal reflux disease (GERD) patients (>25 years) in Kilimanjaro Medical Centre, Tanzania, indicated that 11% of the patients involved in the study identified unsoaked boiled beans to be aggravating their condition (Mwandri et al., 2015) The significant improvement in attitudes towards soaking suggests that children and possibly their households may become more accepting of the recommended practice of soaking maize and beans. However, since parents/guardians were not included in the present study, the extent to which these practices were adopted at home is unknown.

Prior to the intervention, more than half of participants in both the intervention and comparison groups perceived inadequate time and insufficient knowledge as barriers to soaking maize and beans and a few participants indicated that inadequate water availability was also a barrier to soaking at their homes. This could be attributed to inadequate awareness of barriers and understanding of the benefits of soaking beans. The barriers to soaking and their mitigation strategies were included in the nutrition education lessons as one of the six constructs of the health belief model (Naghashpour et al., 2014); and as expected, the perceived barriers were reduced post-intervention. The proportion of participants who perceived barriers to soaking maize and beans declined significantly in the intervention group compared to the comparison group. This finding agrees with the findings of a nutrition education study of children of 10-12 years in India which was also based on the Health Belief Model (Naghashpour et al., 2014). Results from this study in India found that nutrition knowledge, attitudes and practices increased, and the barriers to the recommended eating habits reduced significantly (Naghashpour et al., 2014). Since the present study did not provide or increase access to water to the participants’ homes, the perception of reduced barriers could be a result of the education provided by the program. Specifically, students who learned about barriers to soaking and potential ideas to mitigate these barriers, could therefore weigh the benefits of soaking against the perceived barriers in deciding to implement the recommended practices (Naghashpour et al., 2014).

Similarly, following the intervention, the mean score of barriers to fermentation decreased significantly in the intervention group relative to the comparison group. This finding could be attributed to the lessons on the benefits of fermented porridge, the demonstration of how to ferment porridge, along with discussion of barriers to the process and ways of overcoming these barriers. Participants were also involved in the tasting and evaluation of fermented porridge. In this study, participants were asked to indicate how much various barriers limited their ability to ferment porridge flour before preparing porridge, including a lack of time, limited water availability, not liking the taste and a lack of awareness of the benefits of fermenting. We had identified taste as a possible barrier since fermented porridge has a sour taste due to the increased acidity resulting from high activity by the lactic acid bacteria (Kunyanga et al., 2010). After the lessons involving fermentation, there was a significant reduction in the perception of barriers to fermentation of porridge, including the proportion of participants in the intervention group who reported perceiving limited water availability and inadequate knowledge as barriers to fermentation relative to the comparison group. These results could be attributed to the participants’ increased awareness of options to overcome issues that they perceived as barriers. In addition, fewer participants felt that the taste of fermented porridge was a limiting factor in the intervention group than the comparison group, but this was not significant. However, an informal evaluation following the tasting of fermented versus unfermented porridge indicated that a higher proportion of participants in the intervention group liked the taste of fermented porridge. This could have reduced the number of participants who perceived the sour taste of fermented porridge as a barrier in the intervention group. Despite these positive findings, time constraints remained a barrier to fermentation in the intervention and comparison groups. These findings are similar to the findings of a study conducted with junior high school adolescents in Minnesota where they described healthy eating as “very important” but described the preparation of a healthy meal as time-consuming, and therefore they didn’t practice it (Croll et al., 2001). In the present study, time scarcity was identified as a barrier because the participants were going to school and did not find time to practice the lessons learnt on fermentation; only a small number (<20%) participated in porridge preparation at home. Since we did not directly assess what was being cooked at home, it is difficult to draw conclusions concerning reported cooking practices. Other factors like the planting/weeding seasons would also have affected the family schedules. Education programs that promote soaking and fermentation should incorporate meal planning lessons that share options which reduce time as a barrier to soaking and fermentation. Finally, in the region of Homa-Bay where this study took place, most people do not plan for meals a day in advance; rather, they decide what food to cook just before the meal. This could therefore be a barrier to implementing the recommended practices that require prior planning, an issue revealed in other studies (Ducrot et al., 2017; Lavelle et al., 2016).

Overall, the practices of fermenting porridge and soaking maize and beans were low in both the intervention and the comparison groups prior to the study. This could be because of the perceived barriers reported by the participants. After participating in the intervention, practices of fermenting porridge and soaking beans before cooking increased significantly in the intervention group relative to the comparison group. In this study, the number of participants who reported that maize and beans were soaked before cooking increased significantly in the intervention group and not in the comparison group; however, the soaking of beans only was significantly higher than the soaking of maize only or soaking a mixture of maize and beans in the intervention group. This could be attributed to the fact that beans are also eaten on their own, not just for the preparation of nyoyo only. Therefore, the frequency of cooking beans only and using them in nyoyo may explain the higher reported practice of soaking beans. Also, in recent studies, more gastrointestinal problems have been associated with the consumption of unsoaked beans compared to maize and there is less concern about unsoaked maize since there are fewer reports of problems associated with its consumption hence increasing the motivation to soak beans more than maize (Dargie et al., 2018; Fernandes et al., 2010; Mwandri et al., 2015). The significant increase in the implementation of the recommended iron and zinc related practices in the intervention group relative to the comparison group suggests that this aspect of the program was successful in the short term. However, it is important to determine if nutrition education on soaking and fermentation can create long term change at the household level. These findings are similar to the findings of a pulse-based study conducted with children 10-14 years of age in Ethiopia for six months where there was a significant increase in knowledge (p=0.001) of soaking and its benefits, positive attitudes, implementation of practices and consumption of beans (Dargie et al., 2018)

## 5.3 Beta-carotene and Vitamin C Knowledge, Attitudes and Practices

While there are many plant and animal sources of β-carotene and vitamin C, this research focused on green leafy and orange-fleshed vegetables since they are easily accessible to Kenyan rural households who depend on farming as their primary source of livelihood (Walton et al., 2012). In this study, participants learned about the benefits of β-carotene and vitamin C and the importance of consuming good sources of these nutrients regularly in the form of green leafy and orange-fleshed vegetables. In addition, lessons involving these vegetables taught participants that green leafy and orange/yellow-fleshed vegetables are rich sources of other vitamins and minerals and that regular consumption can reduce the micronutrient malnutrition rates, similar messages were also communicated in other studies (Republic of Kenya (MoH), 2017).

There is strong evidence that shorter cooking times for green leafy vegetables, retain more vitamin C, β-carotene, iron, zinc and other micronutrients (Diaz et al., 2003; Kutsukutsa et al., 2014; Nutraceutical, 2018; Tumwet et al., 2013) We, therefore, included this message in our lessons. We found that, prior to the intervention, participants were highly knowledgeable regarding the importance of cooking green leafy vegetables for no more than 10-15 minutes, reflecting local cooking practices. In contrast, they had limited knowledge regarding composition of a healthy meal and nutrient sources of iron, zinc, β and vitamin C prior to the intervention. Following the intervention, the number of participants in the intervention and comparison groups who identified preservation of nutrients as the reason for cooking vegetables for a short time remained high and were similar post-intervention. As part of a demonstration, participants were shown examples of a variety of green leafy vegetables, some of which are believed to be unpalatable (bitter) when cooked for only 10-15 minutes, like the spider plant. It is possible that if we had addressed this potential barrier, practices might have been higher in the intervention group. In future programs, it would be useful to address this barrier by including ways of preparing this class of green leafy vegetables that contain high levels of tannins while retaining nutrients (FAO/Government of Kenya, 2019; Kutsukutsa et al., 2014). There was also a significant increase in the proportion of the participants in the intervention group who selected the nyoyo (cooked maize and beans) with added orange/yellow and green leafy vegetables as the most nutritious, relative to the comparison group. These findings reflect our program’s content which is in line with Kenyan guidelines on healthy diets (Republic of Kenya (MoH), 2017), which state that adding green leafy and orange/yellow-fleshed vegetables to nyoyo increases the micronutrient (β-carotene and vitamin C) content of this local dish. Further, the knowledge of nutrient sources of β-carotene and vitamin C increased in the intervention group than the comparison group. In this study, a significantly higher proportion of the intervention group identified orange-fleshed vegetables as sources of β-carotene and associated green leafy vegetables with both β-carotene and vitamin C relative to the comparison group. This finding agrees with other studies conducted with school children. Two American school-based nutrition education studies of similar duration conducted with second and fifth-grade children showed significantly greater gains in nutrition knowledge around definitions of a healthy meal and the importance of fruits and vegetables in the intervention groups (Kandiah & Jones, 2002; Schmitt et al., 2019).

Following the intervention, participants in the intervention group had more positive attitudes concerning increasing β-carotene and vitamin C in commonly consumed foods than the comparison group. Specifically, a higher proportion of participants in the intervention group felt it was “important/extremely important” to add green and orange /yellow vegetables to nyoyo to enrich it, relative to the comparison group. These findings may be due to the nature of the program, where participants were shown how to prepare enriched nyoyo using either carrots, pumpkin or orange-fleshed sweet potatoes and green leafy vegetables. The latter ‘enriched nyoyo” differs from the traditional cooking methods in the Ndhiwa community, where nyoyo is cooked by boiling a mixture of maize and beans or boiling a mixture of maize and beans then frying with oil, onions and/or tomatoes. Rather than mixing them in, white sweet potatoes (not orange) and pumpkins are regularly cooked by boiling them separately (FAO/Government of Kenya, 2019) This preparation of enriched nyoyo was presented as an easy way of including foods containing a variety of micronutrients in one meal/plate. Carrot consumption was also promoted to increase the consumption of β carotene. During the informal tasting evaluation, most participants preferred the enriched nyoyo to the usual boiled maize and beans and, as expected, positive attitudes toward enriched nyoyo improved.

Generally, practices of cooking green leafy vegetables and adding orange/yellow fleshed vegetables to nyoyo were low in the intervention and comparison groups prior to the intervention. This could be because, as noted above, the practice of adding green and orange vegetables to nyoyo was not common. Following the intervention, there was a significant increase in the proportion of participants in the intervention group who reported that nyoyo was enriched with green leafy and orange/yellow-fleshed vegetables and green leafy vegetables were cooked for between 10-15 minutes at home relative to the comparison group. These results are similar to a nutrition education study where school children of 10-12 years of age in the Netherlands grew vegetables in the school kitchen gardens, natured, harvested, cooked and finally tasted their own produce over the course of a six-month period. Findings indicated a significant increase in consumption of vegetables which was attributed to the inclusion of cooking activities and food tastings (Leuven et al., 2018) In the current study, the cooking and tasting components of the curriculum may have also facilitated the significant increase in β-carotene and vitamin C practices in the intervention group since liking has been found to be a strong predictor of consumption (Leuven et al., 2018; Wanich et al., 2020). Since very few participants were involved in cooking at home during the study period, the reported increase in the home practices of adding green and orange-fleshed vegetables and cooking green leafy vegetables for 10-15 minutes may reflect children communicating their knowledge and positive attitudes towards the enriched nyoyo to their parents, thereby resulting in an increase in implementing the recommended practices. In summary, it appears that the food-based learning approach in this study was effective in changing or increasing the use of recommended food practices.

## 5.4 Kitchen Gardening Knowledge, Attitudes and Practices

Kitchen gardening provides an inexpensive source of a variety of fresh produce for home use and the surplus produce from a kitchen garden can be sold to generate income to buy other food items (Republic of Kenya (MoH), 2017). This study assessed participant’s kitchen gardening knowledge, attitudes and barriers. Kitchen gardening practices were assessed indirectly through a question that asked about crops grown on the participants’ family farms.

Prior to the present study, approximately half of the participants in both the intervention and comparison groups knew the definition of a kitchen garden. This could be because Ndhiwa is an agriculturally potential zone where farming is the major source of livelihood (Ogenga et al., 2018). Majority of participants reported growing vegetables at home. In this study, the proportion of participants who defined kitchen gardening correctly increased significantly in the intervention group following the intervention, with no change in the comparison group. The increase in knowledge could be attributed to the kitchen gardening lessons and demonstrations conducted as the first topic of the intervention. Participants were taught by an agricultural extension officer who guided them through the establishment of a healthy kitchen garden. The participants prepared the land at the school and planted kales, carrots, and capsicum. They fenced the gardens and watered their crops in the subsequent days of the intervention. At the end of the intervention, the newly established gardens were left under their care. The agricultural extension officer also shared his contact information so that participants could consult with him as needed.

Following the intervention, there was a significant increase in the proportion of participants in the intervention group who felt that it was important/very important to have a kitchen garden at home relative to the comparison group. This could be attributed to the intervention group’s participation in practical kitchen gardening demonstrations conducted using vegetables of their choice (carrots, kales and capsicum). Contrary to our expectations, fewer participants in the comparison group felt that it was “more difficult” to practice kitchen gardening group in the intervention group. These results could be attributed to the fact that it was a weeding season during the intervention period. More participants in the comparison group would have likely participated in the farm work activities after school than the study participants who were attending this program at school. Therefore, participants were not available to work in home kitchen gardens after school. Further, given that participants in the comparison group tended to be older, they would be more likely to be asked to help with the kitchen garden work. However, there was a significant increase in the average kitchen gardening attitudes mean score in the intervention group, which was not observed in the comparison group. This suggests that the practical nature of the kitchen garden activities and the involvement of the agricultural extension officer when teaching kitchen gardening was effective.

Prior to the intervention, most participants in both groups reported that their parents had grown maize, beans, kales, amaranth, black nightshade, and pumpkins on their family farms in the past season, consistent with those that were regularly grown in the study region (Ogenga et al., 2018). On the other hand, few participants reported having grown carrots, orange-fleshed sweet potatoes, spinach, tomatoes, and capsicum. Following the intervention, there was a significant increase in the growing of capsicum and an increase in the growing of carrots and kales in the intervention group relative to the comparison group. This finding could be attributed to the use of these crops in the kitchen gardening demonstrations that were conducted by an agricultural extension officer in the intervention schools and left under the care of the participants. Capsicum seeds were planted in seedbeds at the intervention schools and participants were encouraged to transplant them into the school garden or their home garden, once ready. In this study, Sukuma wiki (kales) was the dominant green vegetable grown and consumed by the majority of participants’ households over the study period; few grew orange-fleshed sweet potatoes. This finding is similar to the findings of a study that assessed the crop varieties of kitchen gardens of women in Kericho, Kenya which found that most households (89.6%) had kales as the main crop in their kitchen gardens (Chepkirui, 2019). Similarly, a Malawian study that assessed the production and consumption of orange-fleshed sweet potatoes indicated that they were grown by very few participants during the farming seasons that followed the intervention (FAO & UNICEF, 2020). Our study had little impact because the implementation period was too short to affect change in crops grown; ending before the kitchen garden crops were harvested.

Similar to our study, a six-month kitchen gardening study with school children of 10-12 years in the Netherlands found a significant increase in the knowledge of kitchen garden crops that were used in the farm demonstrations; however, there was a decrease from 98% to 67% in the participants’ willingness to practice kitchen gardening. The participants stated that weeding was harder than they expected (Leuven et al., 2018). In contrast to our findings, the Netherlands study reported increased consumption of the vegetables grown by participants in the school kitchen gardens. This likely reflects a longer program implementation that lasted beyond the harvesting time such that the participants harvested their vegetables and carried them home to be cooked. This was not possible in the current study but should be considered for future programs.

Among the green leafy vegetables, Sukuma wiki was grown by most households, and its consumption was also high among the intervention and comparison groups. However, the other green leafy vegetables whose consumption was encouraged during the program were grown by only a few households and their consumption remained unchanged following the intervention. Although most families grew pumpkins, very few grew orange-fleshed sweet potatoes and carrots. Green leafy and orange/yellow-fleshed vegetables thrive well in the study area; however, their production at the household level depends on marketability, personal preferences, weather conditions, knowledge of their farming conditions, procedures, and available resources (Ogenga et al., 2018). In this study, the consumption of orange-fleshed vegetables remained low over the study period. This finding is similar to a survey conducted in Malawi that assessed the production and consumption of orange-fleshed vegetables noting that participants did not grow or consume orange-fleshed sweet potatoes due to personal preferences (FAO & UNICEF, 2020).

## 5.5 Food Consumption

The most commonly consumed foods were cereals (maize) and vegetables (kales) in the intervention and comparison groups, while the consumption of the other cereals (wheat, sorghum and millet) and other green leafy vegetables (pumpkin leaves, jute mallow, black nightshade and spider plant) was lower (approximately 40%) and remained the same over the study period. These findings are similar to the results of a cross-sectional kitchen gardening study with mothers of children <5 years of age in Kajiado, Kenya which found that kales ware commonly grown and consumed while pumpkin leaves, black nightshade, and jute mallows were grown by very few households and were less consumed (Kiige, 2004). In this study, spinach was the least commonly consumed in both the intervention and comparison groups prior to and following the study. This is in contrast to the study in Kajiado, Kenya, where spinach and kales were the most grown green leafy vegetables and were sometimes mixed together when cooking (Kiige, 2004). Our findings could be attributed to the limited production of spinach in Ndhiwa area. On the other hand, other vegetables, such as onions and tomatoes that are regularly used as ingredients in staple foods were frequently consumed prior to and following the intervention (FAO/Government of Kenya, 2019). However, capsicum consumption remained low over the study period in both groups. This could be attributed to the short period of program implementation: although there was a significant increase in the number of participants who reported that capsicum was grown at home, the program ended before they were ready for harvesting. While the consumption of fruits was generally low in the intervention and comparison groups, the proportion of participants who consumed mangoes in the intervention and comparison groups “sometimes” and “often” was higher prior to the study and this declined post-intervention with the majority reporting to have never consumed mangoes in both groups. This finding likely reflects a decrease in the availability of mangoes which were being harvested during the December-January period but were not available during the post-test period. The consumption of all orange-fleshed vegetables (pumpkin, carrots, butternuts squash and orange-fleshed sweet potatoes) was also low prior to and following the intervention in spite of our program recommending increased consumption of orange-fleshed vegetables. Although pumpkins were commonly grown in the communities, they were just being harvested at the time of the post-test, with low consumption in the weeks prior to the post-test. Other orange-fleshed vegetables are not common in this region. This finding is similar to the findings of two studies conducted in Meru, Kenya that also indicated low consumption of orange-fleshed vegetables (Muthee, 2018).

The findings are consistent with what we know about typical food consumption in Homa-Bay, Kenya where most people in this region of Kenya rely primarily on plant sources of food, cereals, and vegetables with little consumption of animal protein (Republic of Kenya (MoH), 2016b). Similarly, a scholarly review of articles published between 2000-2014 on dietary intake of school children and adolescents 6–19 years of age in selected developing countries, including Kenya, indicated that participants from the rural areas majorly consumed cereals and other plant-based foods (Ochola & Masibo, 2014)

Since the study did not promote the consumption of specific food items, the food frequency findings show the variety of foods consumed over the study. To assess change in consumption of specific food items, a nutrition education program should be tailored to those specific food items, and they should be made accessible to the participants.

Our findings are also similar to the findings of an experiential study with Slovenian school-age children that found no change in food consumption of the participants following a year-long nutrition education program. In this study, nutrition lessons were incorporated into the regular home science lessons for grade six children. The lack of change in dietary behaviours was attributed to various restraining factors such as a lack of time, poor accessibility to healthy foods at school and general lack of interest to adhere to the recommended dietary habits (Stojan et al., 2012). In contrast, an Ethiopian pulse-based study conducted for six months with children between 10-14 years of age, and their mothers indicated a significant improvement in knowledge, attitudes and consumption of pulses (Dargie et al., 2018)

## 5.6 Relationship Among Knowledge, Attitudes, Practices and Food Consumption

This section explores the relationships among the knowledge, attitudes, practices and food consumption of elementary school participants in this food-based nutrition education program.

In this study, the participants were highly knowledgeable about handwashing and its importance and had very positive attitudes towards it prior to and following the intervention. There was also a significant increase in the practice of handwashing in the intervention group and none in the comparison group. Beside the COVID 19 preventive lessons, the intervention offered additional information based on the health belief model that likely improved their belief that handwashing is important and prevents the spread of germs, and this resulted in improved handwashing practices. This suggests that the intervention was effective in improving pupils’ handwashing practices. Nutrition education programs that involve the development of practical skills are more effective in eliciting positive change in behaviours (Spronk et al., 2014).

There was also a significant increase in knowledge, attitudes and practices related to iron and zinc and a decrease in the number of participants who perceived barriers to soaking and fermenting maize and beans to increase trace mineral availability. However, the consumption of sources of iron and zinc such as cereals and pulses remained similar over the study. The greater improvement in practices could be attributed to the participants’ positive attitudes that likely influenced their belief in the health benefits associated with soaking that were taught such as reducing flatulence (Kinyua, 2013; Naghashpour et al., 2014). Likewise, the significant increase in knowledge, attitudes and practices related to β-carotene and vitamin C in the intervention group relative to the comparison group may be attributed to the same reason. Again, there was no change in the consumption of green leafy and orange-fleshed vegetables following the study.

Generally, the increase in the practice of soaking maize and beans, fermenting porridge and adding one or more orange-fleshed and green vegetables to nyoyo and cooking green vegetables for a maximum of 10-15 minutes could be associated with the fact that most participants tasted and liked fermented porridge and the super nyoyo. A study that assessed the relationship between food liking and consumption among young adults in Australia indicated that food liking greatly influences food consumption (Wanich et al., 2020). As well, a study conducted on school children in the Netherlands highlighted “food tasting” as a component that led to increased consumption of vegetables among school children (Leuven et al., 2018) Food-based nutrition education targeting school children should be continued to increase awareness of nutrients, their sources and the recommended practices that increase their utilization by the body.

There was a significant increase in knowledge of the definition of a kitchen garden and in the number of participants with positive attitudes regarding its practice. Although participants were provided with comprehensive information about kitchen gardening, we have only limited understanding of the impact of the program on the participant’s kitchen gardening knowledge since there was only one question that asked about the definition of a kitchen garden; it was not as informative as were questions pertaining to increasing micronutrient content in the diet.

There was a significant increase in the growing of capsicum and a slight increase in the growing of carrots and kales. These three crops were grown by the participants in the school demonstration farms of the intervention group with the help of an agricultural officer. This is an indicator that a food-based intervention has the potential to increase the variety of kitchen garden crops grown, although there is no strong link between kitchen gardening knowledge and practice, and food consumption, as well as attitude and food consumption.

Our findings are consistent with the findings of other nutrition education programs that have targeted school children in the past. A six-week study with a similar design to the present research that assessed the effects of nutrition education on nutrition knowledge, attitudes and practices of teachers, caregivers and school-age children of 6-12 years in primary schools in Ghana indicated that children’s knowledge and attitudes improved significantly, but there was no change in nutrition practices since the food environment at participants’ homes did not change with parents and teachers trained for only one day (Antwi et al., 2020). In a systematic review of the relationship between nutrition knowledge and dietary practices in 29 previous nutrition education programs, there was a weak but positive correlation (Spronk et al., 2014). Likewise, a study in Slovenia also indicated a weak but positive correlation between knowledge and dietary behaviour (Stojan et al., 2012). In our study, the findings indicated that the increase in knowledge and attitudes resulted into increased practices; however, the increase in knowledge and attitudes did not change food use. Seemingly, according to the HBM, the participant’s positive attitudes were further shaped by the related benefits of the recommended practices that were taught and this resulted in stronger belief about the outcomes/consequences of actions that they would take relating to the recommended practices (Kinyua, 2013; Naghashpour et al., 2014) The findings of the current study showed that improvement in nutrition knowledge led to more positive attitudes towards healthy dietary practices therefore; likely to influence positive healthy behaviour over the long term (Kinyua, 2013). Nutrition education programs based on the HBM appeared to be effective in changing beliefs of school children, which led to increased nutrition practices.

The importance of an education program is measured by its behavioural impact (Naghashpour et al., 2014). The minimal change in recommended food consumption in this study may suggest a limited impact of our program. However, the lack of change in food use in this study could also be attributed to other factors beyond this study's scope. For instance, the short period and timing of the intervention relative to the growing season. As mentioned earlier, a kitchen gardening study that found increased dietary practices was conducted for a longer period which provided the opportunity for children to harvest the vegetables grown (Leuven et al., 2018). Likewise, a two-month nutrition education study based on the HBM conducted with Iranian junior high school students indicated a significant improvement in the intake of calcium-rich foods after three months of follow-up (Naghashpour et al., 2014).

Our study focused on children with no direct measure of cooking practices at home. A pulse-based study that involved school children and their mothers indicated an increase in consumption of pulses (Dargie et al., 2018).

Researchers suggest that future cooking and consumption practices could be impacted; this should be explored through a follow-up study (Antwi et al., 2020). In the current study, there was a strong link between knowledge and attitudes and some practices which did not translate into food use.Knowledge acquisition alone does not guarantee change in food use(Worsley, 2002)

The Health Belief Model (HBM) was used as a framework for this research project with the constructs perceived susceptibility, severity, barriers and benefits being incorporated into the nutrition education curriculum. In order to reduce respondent burden and limited time for assessment, our study assessed two constructs only which were most relevant to the intervention: perceived benefits and barriers. This modification of the HBM provided a framework that captured participants’ perceptions of perceived benefits and perceived barriers associated with the recommended practices. However, while there were positive changes in these HBM concepts, there was no change in behavior, i.e. participants’ food use. This may reflect the fact that the HBM is a psychological model that focuses on attitudes and beliefs and therefore, does not consider other factors that may influence food use, such as environmental and economic factors (Adhikari, 2019). Future studies should consider integrating constructs from the model with other models that account for both environmental and economic factors that influence dietary behaviours.

## 5.7 Conclusion

This study aimed to assess the differences in food-related knowledge, attitudes, practices, and food consumption between children receiving a food-based nutrition education intervention and those who do not.

Objective #1:

**To develop a food-based nutrition education curriculum and questionnaires for evaluation based on the Health Belief Model to assess the outcomes of the intervention**

A culturally relevant food-based nutrition education curriculum with four topics (handwashing and sanitation, enhancing iron, zinc, β carotene and vitamin C content of the diet and improving the nutritional quality of foods grown in kitchen gardens) was developed using the Health Belief Model as a theoretical framework. Data collection tools, including a knowledge, attitude and practices questionnaire and food frequency questionnaire, were adapted from a previous study and included items to assess two HBM constructs: perceived benefits and perceived barriers. The study was first piloted on a group of 15 school children selected from a different village/school that did not participate in the study. The data collection tools underwent minor modifications, including translation into Luo language to improve clarity prior to the implementation of the intervention. This study provided a curriculum for future Farmer’s Helping Farmers nutrition education work with school children.

Objective #2:

**Compare nutrition knowledge, attitudes and practices and food use between the school children who received the food-based nutrition intervention with those who did not receive any intervention.**

All participants in the intervention and comparison groups completed a questionnaire prior to and following the intervention and their knowledge, attitudes and reported implementation of recommended practices and food consumption were compared between groups. The knowledge, attitudes and practices pertained to improving the consumption and availability of micronutrients iron, zinc, β-carotene and vitamin C.

Handwashing knowledge was high among all the participants, and this did not change following the intervention. However, there was a significant improvement in attitudes, a significant reduction in the number of participants who perceived barriers to handwashing and a significant increase in the mean handwashing practices over the study in the intervention group, with no corresponding changes in the comparison group.

Participants’ knowledge and attitudes regarding iron, zinc, β carotene, and vitamin C were also significantly higher in the intervention group than in the comparison group. As well, there was a significant reduction in the number of participants who perceived barriers to the recommended practices relating to iron, zinc, β-carotene, and vitamin C. With regards to practices, the implementation of recommended food-related practices was higher in the intervention group than in comparison group post-intervention. The most striking differences between the comparison and intervention groups were related to participants’ reported implementation of iron, zinc and β-carotene practices. However, there were no significant changes in the consumption of foods targeted by the intervention over the study.

There was little change in the reported farming practices of the intervention group with only the growing of capsicum increasing significantly over the study. Although the production of carrots and kales increased, it was not significant.

Overall, these results suggest that the children benefited from the experiential approach. The food-based nutrition education intervention had a positive short-term effect on food-related knowledge, attitudes, and practices, but there was no change in food consumption of the participants who received the intervention. The long-term impact is not known and should be investigated.

## 5.8 Strengths and Limitations

The strengths of the study include adapting previously used questionnaires and the development of a curriculum based on the HBM (Naghashpour et al., 2014) that also included a food tasting component (Leuven et al., 2018). In addition, having a supervisory committee consisting of diverse disciplinary backgrounds (education and nutrition researchers), brought complementary perspectives to the various components of the study. Also, the translation of the nutrition education messages and the questionnaires into the local Luo dialect, enhanced the understanding of the nutrition messages by the intervention group. Furthermore, having worked as a dietitian in Homa-Bay, the researcher had a good understanding of the context of the community’s cultural food taboos and dietary behaviours. The participants were highly motivated by their involvement in the preparation and evaluation of nutritious meals. The increase in these practices post-intervention could mean that their mothers also learnt from them; therefore, it appears that food-based interventions targeting school children can improve the recommended food-related practices at the household/community (Dargie et al., 2018). The recommended nutrition messages taught were also adding onto the already existing knowledge and regular food practices that were not only evidence-based but also practical and culturally accepted (Gibson, 2011).

There were also some study limitations. The curriculum was developed based on five constructs of the health belief model (perceived susceptibility, severity, benefits, barriers and cues to cues to action); however, for practical reasons, our study assessed the constructs that were most relevant to our participants which were perceived benefits and barriers. We did not assess perceived susceptibility, severity, and cues to action. In terms of assessing knowledge, attitudes and practices, there were limited questions on deworming and kitchen gardening knowledge and practices. Given that this was a pilot study; the focus was on dietary rather than a comprehensive nutritional assessment. As a result, conclusions cannot be drawn regarding the impact of the intervention on the micronutrient status of the participants. Future research should include these components. The questionnaires were based on self-reports by the participants; therefore, the responses could be influenced by social desirability and social approval biases. Social desirability is the tendency to respond in a specific way to avoid criticism while social approval is the tendency to seek praise (Miller et al., 2008). Participants were likely to answer what they know is right as per the expected norms and not necessarily what they practice. Seasonality also affects food use since it determines foods availability on the farms and the prices in the local markets (Heckbert, 2020) (Heckbert, 2020) The short period of program implementation and limited availability of some foods during the study period made it difficult to detect a change in food use (Bello & Pillay, 2019). Besides, the food security at homes where the participants would implement the recommended taught practices was not assessed. Moreover, as children, the participants were dependent on their parents; they were not the main decision-makers choosing foods cooked at home. Therefore, it is recommended that caregivers, especially mothers, be involved in a similar study since they are responsible for food availability at the household level (Antwi et al., 2020).

## 5.9 Future Research

1. This study signals the need for further research to assess the long-term effect of this research on the sustainability of changes in knowledge, attitudes, practices and ultimately food intake at the households of the school children involved in this study. For instance, it is important to determine if nutrition education on soaking and fermentation can create long term change at the household level.
2. Similar research could be conducted with a larger sample which would provide more statistical power. Parents/caregivers and teachers should also be involved to assess changes in food practices/food use, kitchen gardening practices and attitudes. Direct targeting of women has shown higher success rates and possibilities of the long-term sustainability of food-based projects (Muthee, 2018). This is because women are the primary producers, food preparers and caregivers.
3. It is recommended that participants’ preference for recommended foods or preparation methods (e.g. soaked and un-soaked beans) be assessed in future studies since food preference is an important predictor of food consumption (Wanich et al., 2020).

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# Appendices

## Appendix 1: Information Letters, Introductory Scripts, Consent form for Parents, Assent form for Children

Date

Dear Parent,

This letter describes a research study to be conducted in your village through the University of Prince Edward Island.

**The purpose** of the study is to collect information on the children’s nutrition knowledge, attitudes, practices and food consumption after and following a six-week food-based nutrition education program.

**Why is this study important?** As you know, micronutrient malnutrition is a problem that affects people across the lifespan. School-age children (pre-adolescents) who are starting to be involved in food preparation at home are targeted since they need to learn and continue with the recommended nutrition practices that would promote maximum utilization of nutrients by the body. This study will provide us with important information about their nutrition knowledge, attitudes, practices and food consumption.

We will also prepare a report for your village to help parents; teachers and students understand the recommended nutrition practices. Although the results may not have an immediate benefit for your child, we believe that our study will inform future nutrition activities that would improve the nutritional health of this community overall.

**There are two parts of the research:**

1. Students will be asked to complete an in-class survey about their nutrition knowledge, attitudes, practices and food consumption. We will ask students not to include their names on the survey. A trained research assistant will be present while students complete the survey. The survey will take about 1 hour 45 minutes.

2. Students will be asked to attend a six-lesson learning program that will take place in open community venues following a timetable and strict adherence to COVID-19 containment measures by the Ministry of Health and Ministry of Education, Kenya. We will:

* Train the research assistant to make sure he/she is sensitive to children’s concerns and can answer children’s questions; we will assure students that this is not for the passing of exams; rather, it's about assessing the understanding of each participant on the topics taught in relation to their regular nutrition activities at home.
* Pre and post-assessment results will be shared with the child only at the end of the study.
* Participants’ data will be kept private.

Only students with written permission from their parents, and who are willing to participate themselves, will be included in the study. If you/your child is not comfortable with participating in the study, you and or he/she have the right to refuse to participate.

Although we cannot guarantee complete confidentiality among the students who take part, we will ask students to keep what they write confidential. All information obtained from this study will be destroyed after the study is completed. There will be no identification of names on any information we obtain. Only the researchers will see the information.

This project has been reviewed and approved by the UPEI Research Ethics Committee. Although there are no known risks to taking part in the study, this study is voluntary: the final decision to take part rests with you and your child. We will appreciate your cooperation in permitting your son or daughter to join in the research. However, there is no penalty of any kind if he/she does not take part or if you or your child decides to withdraw from the study later. Either you/your child may withdraw at any time before or during the research by advising the researcher or research assistant of your decision, even if you agree to take part now. If you have any questions about the study, please call Dr. Jennifer Taylor (University of Prince Edward Island) at 566-0475.

If you are willing to have your child take part in this study, please complete the attached permission form by date, and have your son or daughter bring it to the research team on the first lesson. All students must return a signed permission form to take part. Children will not be permitted to take part if he/she does not have the form when he/she arrives. If you have any comments about your child’s participation in this study, please contact the Chair, Research Ethics Committee, University of Prince Edward Island, through the secretary at the Office of Research Development, 566-0637. You can also call Jennifer Taylor at the University of Prince Edward Island, 902-566-0475.

Sincerely,

Jennifer Taylor, PhD

Co-Principal Investigators, Food-Based Nutrition Education research study

**Parent PermissionForm**

By signing this form, I give my permission for my child (print name) to take part in the above study.

* I understand that my child's participation is entirely voluntary.
* I have read the attached letter, and I understand the purpose of the study.
* If I agree that my child can take part, he/she will be asked to complete an in-class survey on the nutrition knowledge, attitudes, practices and food consumption before and following a food-based nutrition education program. This will last about I hour and 45 minutes.
* This study is completely anonymous and confidential. My child’s name will not be recorded at any time, on any question sheet.
* All completed questionnaires will be kept in locked cabinets at the University of Prince Edward Island; only the researchers can see and use it.
* Although the results may not have an immediate benefit for my child, the study will help improve the nutritional KAP and food consumption overall.
* There are no known risks in taking part in the study.
* My child may refuse to take part or may withdraw from the study at any time without any penalty by indicating his / her wish to the researcher (Jennifer Taylor).

If I have any questions, I can call Dr. Jennifer Taylor (University of Prince Edward Island) at 902-566-0475. I will keep one copy of this form for my records.

I consent to my child’s participation in this study by signing below.

Signature of parent ------------------ Contact--------------------- Date---------------------

*\*****\*\* Please give your child this form (signed) to return to the researcher on the first lesson \*\****

**Introduction Script**

Thank you for allowing us to come to your community today. We are nutrition students from the University of Prince Edward Island in Canada. We are working with Farmers Helping Farmers to assess the impact a food-based nutrition education program would have on school-age children in your community. We will give out questionnaires that will be completed by each pupil in an exam setting. The questionnaires have questions about the foods that you eat, the way you prepare foods at home and the knowledge behind the food preparation practices and hygiene. You may choose not to answer some of the questions if they are hard for you. However, we will appreciate if you can answer as many as possible to help us gather as much information as possible around these topics. This assessment will help Farmers Helping Farmers and UPEI to work with school-age children on food-based nutrition education projects. We will not share any information collected from you with anyone else. At no time will your identity and information be shared.

Our survey will take about 1 hour 45 minutes.

Are you ready to proceed?

**Information letter for Survey Participants**

Dear participant,

My name is ……………………………………………. I am part of a nutrition research team from UPEI and FHF. Our research is part of a larger project led by Farmers Helping Farmers (FHF), University of Prince Edward Island (UPEI) and Kenyatta University. The goal of this research project is to assess whether, nutrition knowledge, attitudes and practices of school-age children in Ndhiwa Sub County would improve following a food-based nutrition education program. The information we collect will help us to validate the nutrition education curriculum we have developed for use in schools by FHF. We would like to ask you some questions about the foods you eat, your cooking methods, and your knowledge about the recommended cooking procedures and food use. The survey will take about one hour and forty-five minutes.

Your participation in the survey is voluntary, you do not have to participate in the survey if you do not want, but we hope that you will answer the questions since your views are very important. We assure you that this survey is anonymous, meaning that there should be no way to connect your responses with you. All of your answers are confidential and will not be shared with anyone other than the researchers. You are free to withdraw from the study whenever you want, and there will be no negative consequences if you do. If you have any questions about the study, feel free to ask us at any time (see our contacts below). If you have any concerns about the ethical conduct of this study, also feel free to contact the UPEI Research Ethics Board at (902) 620-5104, or by email [reb@upei.ca](mailto:reb@upei.ca).

Your assistance and cooperation are highly appreciated. You will receive one Pencil and a biro as a token of appreciation for participating in the study.

Sincerely,

**Julie Oyoo**

**0713906166**

**jaoyoo@upei.ca**

You can also contact:

Dr. Jennifer Taylor [jtaylor@upei.ca](mailto:jtaylor@upei.ca)

**Assent form for Survey Participants**

We invite you to participate in this research. Your signature or thumbprint on this assent form means:

* Your parent has given his/her consent for you to participate in this study
* You have been informed about the research, and you understand its details.
* You understand that participating in this research study is voluntary.
* You understand that you can withdraw from the study at any time, and there will be no consequences.
* You understand that you can ask any questions, at any time, about the research study.
* You understand that there are minimal risks and benefits associated with the study.
* You understand that the answers you provide will be kept confidential.
* You understand that you can keep one copy of the signed or thumb printed consent form if you so wish.
* You understand that if you have any concerns about the ethical conduct of this study, you are free to inform your parent to contact the UPEI Research Ethics Board at (902) 620-5104, or by email [reb@upei.ca](mailto:reb@upei.ca).

…………………………………… ………………….……..

**Signature or thumbprint of participant** **Date**

The researcher who obtained consent: I have explained this study to the best of my ability. I have invited questions and given answers to the participant. Therefore, I believe that the participant understands what is involved in being part of the research study.

……………………………… .…..…….……….…….

**Signature of Researcher**  **Date**

**Research contacts:**

Julie Oyoo - 0713906166 or jaoyoo@upei.ca

Dr. Jennifer Taylor ([jtaylor@upei.ca](mailto:jtaylor@upei.ca)

## Appendix 2: Food Frequency Questionnaire (FFQ)

Consider the past week (7 days). Please tell us how often you consumed the foods or groups of food listed below by placing a checkmark in the box that applies to you**.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Food item** | **Daily** | **Often (4-6 times a week** | **Sometimes (1-3 times a week)** | **Never in the past week/past 7days** |
|  | Maize |  |  |  |  |
|  | Sorghum |  |  |  |  |
|  | Millet |  |  |  |  |
|  | Cassava |  |  |  |  |
|  | Wheat products (bread mandazi, chapati, doughnuts) |  |  |  |  |
|  | Beans |  |  |  |  |
|  | Green grams |  |  |  |  |
|  | Orange fleshed sweet potatoes |  |  |  |  |
|  | Pumpkin (Budho) |  |  |  |  |
|  | Carrots |  |  |  |  |
|  | Butternut |  |  |  |  |
|  | Pawpaw |  |  |  |  |
|  | Mangoes |  |  |  |  |
|  | Orange |  |  |  |  |
|  | Ripe bananas |  |  |  |  |
|  | Pineapple |  |  |  |  |
|  | Watermelon |  |  |  |  |
|  | Avocado |  |  |  |  |
|  | Kales (Sukuma wiki) |  |  |  |  |
|  | Spinach |  |  |  |  |
|  | Black nightshade (Osuga) |  |  |  |  |
|  | Spider plant(dek) |  |  |  |  |
|  | Amaranth (Ododo, Mchicha) |  |  |  |  |
|  | Pumpkin leaves (Susa) |  |  |  |  |
|  | Kunde leaves (boo) |  |  |  |  |
|  | Jute (Apoth) |  |  |  |  |
|  | Cabbage |  |  |  |  |
|  | Onions |  |  |  |  |
|  | Tomatoes |  |  |  |  |
|  | Coriander (Dania) |  |  |  |  |
|  | Capsicum (pilipili hoho) |  |  |  |  |
| Groundnuts |  |  |  |  |
| Milk, milk tea, mala, yoghurt |  |  |  |  |
| Meat (Beef, liver, goat, sheep, pork) |  |  |  |  |
| Chicken/chicken liver/chicken organs |  |  |  |  |
| Eggs whole or in cooking, e.g. (In pancakes) |  |  |  |  |
| Fish/omena |  |  |  |  |
|  | Oil or fat |  |  |  |  |

## Appendix 3: Children's Nutrition Knowledge, Attitudes and Practices Questionnaire

**Village Number**

**Student Code Number:**

**Instructions:** *For each question, choose only one answer, circle your response*

**Section 1:** **About you**

1. What is your date of birth----------
2. What is your gender?

* Female
* Male
* Prefer not to answer
* Other, please specify --------------

1. Do you live with your parent/parents, or are you under the care of a guardian?

(1) Yes

(2) No.

**Section 2: Nutrition Knowledge Questions**

*The questions in this section are assessing what you know*?

1. What is the main source of water for home use? (check one)
2. Piped water to a public tap
3. Borehole Protected
4. Dug well
5. Spring
6. Rainwater collection

1. Is the water treated at home before drinking? (Check one)
2. Yes (if yes proceed to question 6)
3. No (If no, proceed to question 7)
4. How can you make water safe for drinking at home? Select all that applies your home.
5. Chemical treatment, e.g. addition of chlorine
6. Boiling
7. Sieving
8. Putting it to settle then, decanting

7. Proper handwashing requires:

1. A quick rinse of the hands with clean water for at least 20 seconds
2. Rubbing hands together under clean running water for at least 20 seconds
3. Rubbing wet hands together with soapy water for at least 20 seconds, then rinse hands to remove soap.
4. Rubbing wet hands with soap and then rubbing the back of your hands, between your fingers and the nails for at least 20 seconds, then rinse hands to remove soap.

8. Why do we wash our hands?

1. To avoid punishment at school
2. To keep them clean and prevent the spread of germs
3. We wash our hands for fun
4. None of the above

9. Which statement correctly describes what a kitchen garden is?

1. It is a piece of land at home or at school where a variety of vegetables are grown majorly for home use.
2. It is a piece of and where crops are grown majorly for sale or commercial use
3. It is a piece of land where people buy and sell foodstuff
4. It is a piece of land where crops are grown for transplanting

10. When cooking githeri, why is it important to add green vegetables towards the end of cooking? Tick all that apply

* To preserve the nutrients in the vegetables
* To save on cooking fuel
* To avoid wasting time
* To make the vegetables remain green

1. Which of these meals do you think provides children with the greatest variety of nutrients?
2. Githeri containing maize only
3. Githeri containing maize and beans only
4. Githeri containing maize and beans, kales
5. Githeri containing maize, beans, carrots and kales
6. Githeri containing maize, beans, carrots/orange-fleshed sweet potatoes, kales and oil
7. All of the following are benefits of soaking maize and beans in water before cooking except ONE. Which one is NOT a benefit of soaking?
8. It reduces gas-forming compounds from beans and hence improves digestion.
9. It reduces anti-nutrients in cereals and legumes; this makes it easy for the body to utilize iron and zinc in foods eaten.
10. It softens maize and beans: it reduces cooking time and saves on fuel
11. It increases gas-forming compounds

13. Whenever you are cooking maize and beans at home, do you soak maize and beans before boiling?

1. (Yes) b) (No)

If your answer in question 21 is (yes), for how long do you soak?

1. 30- 45 minutes
2. 8 -22 hours
3. 1-4 Hours hour
4. Don’t know
5. 5-6 hours

14. In your home, whenever githeri is prepared, are any of the following foods added? Please check all that apply.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Yes | No | Don’t Know |
| Carrots |  |  |  |
| Green leafy vegetables |  |  |  |
| Pumpkin |  |  |  |
| Orange-fleshed sweet potatoes |  |  |  |
| Oil or fat |  |  |  |

15. Match the following foods with the main nutrients they supply in food

|  |  |
| --- | --- |
| Maize  Beans  Green and yellow-fleshed vegetables Orange fleshed sweet potatoes | Vitamin A  zinc  Iron |

16. Which one of the following practices preserves iron and zinc in maize and beans?

1. Drying before boiling
2. Roasting before boiling
3. Soaking before boiling
4. Sorting before boiling

**Nutrition practices questions**

***This section includes questions about food preparation at home.***

17. How often do you do the following activities?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Always | sometimes | rarely | I don’t know |
| Washing your hands after visiting the toilet |  |  |  |  |
| Washing your hands whenever you want to eat |  |  |  |  |
| Washing your hands before handling or preparing food |  |  |  |  |
| Fermenting porridge flour for making porridge at home |  |  |  |  |
| Adding one green and one orange vegetable to githeri when cooking githeri |  |  |  |  |
| Cooking green vegetables for 10 -15 minutes |  |  |  |  |
| Soaking maize before cooking githeri |  |  |  |  |
| Soaking beans before cooking |  |  |  |  |

18. Who usually makes meals at home? Choose all the correct answers

1. Myself
2. Mother
3. House help
4. Father
5. Other (specify)------------

19. How often do you prepare meals at home?

1. Always = everyday
2. Most of the time = Several times a week
3. Sometimes = once or twice a week
4. Not very often (a few times per month)
5. Never – proceed to question 21
6. If you prepare meals, which of the following do you prepare or help prepare regularly?

* Porridge
* Tea
* Githeri
* Meat
* Eggs
* Ugali
* vegetables
* Others (specify)\_\_\_\_\_\_\_\_\_

21. When are green vegetables added when githeri is prepared at home?

1. Towards the end of cooking githeri
2. In the beginning, when starting to boil maize and beans
3. Green vegetables are usually cooked separately then served on the table
4. Don’t know

22. How much would the following limit your ability to soak maize and beans before cooking, and ferment porridge flour at home?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Not at all  1 | 2 | 3 | 4 | A great deal  5 |
| Not having enough time for soaking |  |  |  |  |  |
| Not aware of the importance of soaking |  |  |  |  |  |
| Not having enough water to soak |  |  |  |  |  |
| Other reason (specify) |  |  |  |  |  |

23. Do you or your family have a kitchen garden at home?

1. Yes (If YES proceed to question 24)
2. No (If NO proceed to question 25)

24. How often did you visit your kitchen garden at home to take vegetables in the past four weeks?

1. Everyday
2. Few times per week
3. Once in a week
4. Few times per month
5. Rarely/Never

25. We would like to know the source of the foods you consume at home.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Food item.** Circle yes or no | **Which of the following do you grow in your home Shamba** | | **Which of the following do you get directly from your shamba to cook at home regularly** | | **Which of the following do you buy for use at home?** | | **Don’t know** |
| Carrots | yes | No | Yes | No | yes | no |  |
| Pumpkin | yes | No | Yes | No | yes | no |  |
| Orange fleshed sweet potatoes | yes | No | Yes | No | yes | no |  |
| Amaranth | yes | No | Yes | No | yes | no |  |
| Black nightshade | yes | No | Yes | No | yes | no |  |
| Tomatoes | yes | No | Yes | No | yes | no |  |
| Spinach | yes | No | Yes | No | yes | no |  |
| Sukuma wiki | yes | No | Yes | No | yes | no |  |
| Any fruit (specify) | yes | No | Yes | No | yes | no |  |
| Maize | yes | No | Yes | No | yes | no |  |
| Beans | yes | No | Yes | No | yes | no |  |
| Meat | yes | No | Yes | No | yes | no |  |
| Chicken | Yes | No | Yes | No | yes | no |  |
| Milk | yes | No | Yes | No | yes | no |  |
| Fish/Omena | Yes | No | Yes | No | yes | no |  |
| Any other foods(specify) |  |  |  |  |  |  |  |

**Section 3: Nutrition Attitude questions**

*This section is assessing what you think or feel about food preparation practices.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Question 26. | **Extremely important** | **Very important** | **Important** | **Not very Important** | **Not important at all** |
| 1. How important do you think is it to regularly wash your hands with soap and water? | A | B | C | D | E |
| 1. How important do you think it is to always serve meals with cooked green vegetables? | A | B | C | D | E |
| 1. How important do you think it is to always soak maize and beans before boiling | A | B | C | D | E |
| 1. How important do you think it is to always eat orange-fleshed sweet potatoes, butternuts, carrots or other yellow and orange-fleshed vegetables (if cooked separately or together with meals like githeri)? | A | B | C | D | E |
| 1. How important do you think it to always deworm children? | A | B | C | D | E |
| 1. How important do you think it is to have a kitchen garden at home? | A | B | C | D | E |
| 1. How important is it to always use whole maize flour and not polished maize flour? | A | B | C | D | E |
| 1. How important is it to avoid taking tea with meals containing iron? | A | B | C | D | E |
| 1. How important is it to always use safe and clean water? | A | B | C | D | E |
| 1. How important is it to always eat healthily | A | B | C | D | E |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Question 27. | **Extremely difficult** | **Very difficult** | **Difficult** | **Not very difficult** | **Not difficult at all** |
| 1. How difficult do you think is it to regularly wash your hands with soap and water? | A | B | C | D | E |
| 1. How difficult do you think it is to always add green vegetables to regular meals like githeri or to serve meals with separately cooked green vegetables? | A | B | C | D | E |
| 1. How difficult do you think it is to always soak maize and beans before boiling | A | B | C | D | E |
| 1. How difficult do you think it is to always eat orange-fleshed sweet potatoes, butternuts, carrots or other yellow and orange-fleshed vegetables (if cooked separately or together with meals like githeri)? | A | B | C | D | E |
| 1. How difficult do you think it to always deworm children? | A | B | C | D | E |
| 1. How difficult do you think it is to have a kitchen garden at home? | A | B | C | D | E |
| 1. How difficult is it to always use whole maize flour and not polished maize flour? | A | B | C | D | E |
| 1. How difficult is it to avoid taking tea with meals containing iron? | A | B | C | D | E |
| 1. How difficult is it to always use safe and clean water? | A | B | C | D | E |
| 1. How difficult is it to always eat healthily? | A | B | C | D | E |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table 17: Nutrition education session plan for grade 6 children** | | | | | | |
| Session # Title/focus | Topics | Session objectives | Content | Learning activities | Materials | Key Nutrition messages |
| 1. Introduction | Introduction of the research team, the background and intervention program  Pre-Intervention assessment | The participants will be able to appreciate the goals of learning the course | General course outline | Pretest: Knowledge, Attitudes & Practices and food consumption. | Flip chart  Marker pens  Name tags | Participants are encouraged to participate in the planned nutrition education sessions actively |
| 2. Sanitation and the “Wash” Program | Handwashing | Participants will be able to understand that they are susceptible to worm infestation and MNM following poor; hygiene and sanitation  Participants will be able to explain the benefits of handwashing  Participants will understand the consequences of Inadequate handwashing | prevention of parasites  Benefits of handwashing and other hygiene practices  Effects of inadequate hygiene/ handwashing on micronutrient status.  Procedure for handwashing  Barriers to regular handwashing | Demonstration of handwashing by teacher  Practical handwashing session | Hand washing facility, water, soap, sanitizers, paper towels and handwashing procedure on a flip chart | Regular handwashing prevents germs and parasites from getting into our bodies. |
| 3.Preserving and enhancing dietary intakes of nutrients and maximization | Zinc and iron | Identify the food sources of iron and zinc in their community  The participants will appreciate the benefits of zinc and iron lessons  Participants will understand how children their age are susceptible to micronutrient malnutrition.  Participants will be able to explain the benefits of soaking maize and beans before cooking. | Zinc and iron food sources,  Benefits and risks of deficiencies  Benefits of soaking cereals and legumes  Barriers to the soaking of legume and cereals  Benefits of fermentation | Presentation  Group activity  -Soaking of maize and beans  -Fermentation of porridge | Posters images of cereals and legumes, food models  Containers, maize, beans and water  Containers porridge floor and cooking stick | Deficiencies of iron and zinc nutrients can cause disorders that affect growth and development  Legumes and cereals (maize and beans) are rich sources of non-haem iron and zinc.  Soaking of maize and beans reduces antinutrients and protects iron. It also makes it easier to digest. |
| 4.Promotion of the intake of various green leafy and orange-fleshed vegetables | Vitamin A and C | Participants will be able to explain the timing and cooking methods that preserve vitamins in vegetables.  Participants will be able to explain the benefits of adding at least two vegetables in addition to tomatoes and onions to githeri.  Participants will also understand the importance of using one green and one orange vegetable as often as possible/daily | Vitamin A & C (Benefits, risks of deficiencies, dietary sources)  Identification of food sources of vitamin A and C in the community  Cooking methods that preserve vitamin A and C in food  Barriers to the preparation of enriched githeri | Brainstorming session on food sources of vitamin A  Brainstorming session on food sources of vitamin C  Practical activity  -Preparation of githeri | Laminated images of green and orange/yellow vegetables  Soaked maize and beans, fuel, cooking pot, cooking stick, kales, onions, tomatoes, oil, salt, disposable plates, and spoons  -Simple, super githeri recipe | Green leafy vegetables such as kale, spinach, cowpea leaves are rich in nutrients such as vitamin A, folate, and others, which are essential for growing children.  Vitamin C enhances the absorption of iron in the body  When cooking githeri add green vegetables towards the end of cooking to preserve nutrients. They should cook for about 10-15 minutes  It is important to add green leafy vegetables & orange vegetables like orange-fleshed sweet potatoes, carrots, pumpkin, & butternut to githeri during preparation to enrich it with vitamins*.* |
| 5.Promotion of easy access to a variety of vegetables | Kitchen gardening | Participants will be able to define a kitchen garden  Participants will be able to identify/list a variety of vegetables that can be grown in a kitchen garden  Participants will be able to explain the benefits of having a kitchen garden | Kitchen garden definition  Benefits  Barriers to having a kitchen garden  Types of kitchen gardens | presentation  Demonstration | Laminated images of different types of kitchen gardens  Seedlings of kales, black nightshade, spinach, spider plant pumpkin and a demonstration space | A kitchen garden is a piece of land next at home or school where a variety of vegetables are grown for home consumption  Kitchen gardens promote easy access to a variety of micronutrient-rich vegetables  Every homestead needs to have a kitchen garden |
| 6. Post assessment |  |  | Questionnaires | Knowledge, Attitudes & Practices and food consumption post-assessment survey |  | A word of appreciation to the students |

|  |  |  |  |
| --- | --- | --- | --- |
| **Table 18:** **Summary of the Study Variables and Indicators** | | | |
| **Objective** | **Indicator** | **Variable** | **Type** |
| 1. To evaluate the effectiveness of food-based nutrition education program by comparing children's food-related KAP prior to and following a four-week nutrition education program. | **Knowledge scores**: iron/ zinc,  vitamin A, C, sanitation  Kitchen garden  **Practice scores:**  Iron/zinc,  Vitamin A, C, sanitation  Kitchen garden  Other  **Attitude scores**:  Iron/zinc,  Vitamin A, C, sanitation  Kitchen garden  Group:  Gender | Iron/zinc knowledge= Q6+12+13+15+16  Vitamin A & C knowledge= Q10+11+14+15+25  Sanitation knowledge= Q4+ 5+6+7+8  Kitchen garden= Q9  Others= Q1+3  Iron/zinc practice= Q17+22  Vitamin A & C practice= Q17+21  Sanitation practice= Q17  Kitchen garden practice= Q23+24+25  Others= Q19+20  Iron/zinc attitude= Q26+27  Vitamin A&C attitude = Q26+27  Sanitation attitude= Q26+ 27  Kitchen garden= Q26+27  Intervention, comparison  Male, female, other= Q2 +Q3 +13+18 | Score=ordinal  Ordinal  Ordinal  Nominal  Nominal |
| 1. To evaluate the effectiveness of food-based nutrition education program by comparing food consumption prior to and following a four-week nutrition education program. | Frequency of use of recommended foods/food groupings | Individual foods in the FFQ (#) expressed as daily occurrences  e.g. **Daily-1;**  **4-6X week=5/7 or 0.71=;**  **1-3X week. =2/7=0.28;**  **Never=0;**  Grains: Expressed as the sum of daily occurrences  Dark green leafy vegetables: Expressed as the sum of daily occurrences  Orange/yellow vegetables & fruits: Expressed as the sum of daily occurrences  Other vegetables: Expressed as the sum of daily occurrences  Other fruits: Expressed as the sum of daily occurrences  Beans and pulses: Expressed as the sum of daily occurrences  Nuts: Expressed as the sum of daily occurrences  Dairy/milk products: Expressed as the sum of daily occurrences  Eggs: Expressed as the sum of dailyoccurrences  Meat, fish, insect, organ meets Expressed as the sum of daily occurrences  Oil: Expressed as the sum of daily occurrences | Ratio (continuous) |

## Appendix 4: Food-Based Nutrition Education Curriculum

*Food-based Nutrition Education Instructional Manual for school-age Children*

Julie Oyoo

October 2020

University of Prince Edward Island, Canada

**Preamble**

This food-based nutrition education curriculum has been developed in partnership with the University of Prince Edward Island, Canada, and Farmers Helping Farmers (FHF). FHF is an organization that has worked in Kenya for many years, focusing on food-based education for women’s self-help groups, horticulture support and dairy management. This initiative aims to reduce the serious problem of micronutrient malnutrition among Kenyan school children and their families by enabling children to prepare more nutritious meals at home which incorporate vegetables from local kitchen gardens, which are in turn supported by FHF. The curriculum also includes information and activities designed to improve nutrient utilization, particularly for Iron and Zinc, which are the most common micronutrient deficiencies among Kenyan children. Children will also be encouraged to have diversified kitchen gardens and to practice healthy behaviours to reduce parasite infestation, which also increases the risk of micronutrient malnutrition. This curriculum aims to improve nutrition knowledge, attitudes and food-related practices of school-going children who are at the food preparation age (8 – 10 years). Specifically, the curriculum focuses on knowledge, attitudes and practices that promote intake and utilization of Zinc, Iron, vitamin A and C according to Kenyan food and nutrition guidelines.

The curriculum is based on the Health Belief Model (HBM), which has been used for decades to develop effective health education programs. The HBM constructs of perceived severity (how serious is micronutrient malnutrition?), susceptibility (how is micronutrient malnutrition likely to occur among children and their families?), benefits (how does preparing more nutritious meals and handwashing make you healthier? And barriers (what makes it challenging/difficult to implement food-based strategies?) are included in the curriculum that follows.

|  |  |
| --- | --- |
| **Lesson No.** | **Topics** |
| **1** | **IT'S ALL ABOUT FOOD!**  **Introduction**  Introduce the research team and participants  Explain the agenda of the research  List the rules that will be followed during the lessons  Discuss what they can expect to learn from the lessons  Pre-test |
| **2** | **THE HYGIENE EXPERTS**  **Handwashing**  Definition of terms  The glitter handshake experiment  Practical session (handwashing with soap)  Importance of regular handwashing with soap  Barriers to handwashing  Other hygiene practices |
| **3** | **MAXIMIZING ZINC AND IRON IN FOODS**  **Iron**  Prevalence of iron and zinc deficiency  Definition of terms  Importance of iron and zinc  Sources of iron and zinc  Recommended food preparation practices that preserve iron  Practical activity (Fermentation)  Key messages |
| **4** | **Zinc**  Importance of zinc  Sources of zinc  Recommended food preparation practices that preserve zinc  Practical activity (soaking)  Key messages |
| **5**    **6** | **FILL YOUR PLATE WITH COLOUR**  **Vitamin A**  Prevalence of vitamin A deficiency  Definition of terms  Importance of vitamin A  Sources of vitamin A  Barriers to accessing vitamin A food sources  Group activity (Identifying ways of improving intake of vitamin A-rich foods) |
| **Vitamin C**  Importance of vitamin C  Food sources of vitamin C  Vitamin C deficiency  Barriers to accessing vitamin C food sources  Cooking methods that preserve vitamin C  Practical activity (preparation of enriched githeri)  Key messages |
| **7** | **THE KITCHEN’S TOP SECRET: Establish and Maintain a Healthy Kitchen Garden**  **Kitchen Gardening**  Definition  Importance  Types of kitchen gardens  Kitchen garden crops  Practical activity (demonstration on the preparation of kitchen garden) |
| **8** | **WRAP UP**  Post-test  Appreciation |

**Session 1**: **IT IS ALL ABOUT FOOD!**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

**Learning Objective(s):**

* 90% of the participants will understand the purpose of the food-based nutrition education program and will be able to identify the components of the program.

|  |
| --- |
| **Background information**  Nutrition education is important to children, especially for pre-adolescents. From the age of seven, a child’s weight and height begins to increase more quickly in preparation for adolescence. At this age, children may want to help prepare food and to socialize with peers during meal times. They enjoy snacks and develop strong food likes and dislikes. This is a time when children are becoming independent from the family, and are at risk of developing negative eating habits. These children spend a significant amount of time at school and may have one or even two meals in that setting. They may be nutritionally vulnerable, depending on their socio-economic status and geographical location. Children from households with limited income are likely to consume a starchy diet low in animal protein and high in anti-nutrients. This limits the bodies’ access to micronutrients.  This food-based nutrition education program is intended to enable grade 6 pupils to enhance their food-related knowledge and attitudes and adopt recommended food-related practices at home. It will improve their micronutrient intake and reduce the risk of micronutrient deficiencies like vitamin A, C, iron and zinc, which are common in Kenya. The curriculum consists of four weekly sessions that will take approximately one hour each and involves both theory and practical learning. Any special terms used will be defined.  Micronutrient malnutrition negatively impacts learning and a child’s physical development (weight and height). |

|  |  |
| --- | --- |
| Instructional Session Content  (Educational message and procedures) | Resources and References |
| Introduction  Introduce yourself, your group members, and explain who you are and why you are there, provide an overview of your session, cover key points for informed consent and address housekeeping issues.   * Ensure that all participants have returned a signed consent form * Ask participants to write their preferred name on name tags which they will pin on their shirts or collars during lessons | Marker pens, shorthand notebooks |
| Time: 10.15 a.m. to 1.30 pm   * Pre-intervention assessment * Participants will be assessed prior to the nutrition education program to determine what the participants know and think about nutrition, kitchen gardening, sanitation, and hygiene before we begin the nutrition education program. Reassure the students that this is not a competition.   Procedure   * *Ask students to sign their consent forms. Ensure that parental consent is obtained before participating.* * *Read out the instructions and time for the assessment* * *Give out the pre-intervention assessment questionnaires* * *Research assistants to provide support to participants as needed* | Pens, pre-assessment survey questionnaire, name tags |
| Conclusion and wrap up   * Collect the pre-assessment questionnaires * Thank the participants and collect name tags * Inform participants of the next class |  |

**Session 2: THE HYGIENE EXPERTS**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

**Learning Objective(s):**

By the end of this topic, 90% of the participants will;

* Understand the importance of handwashing
* Understand the correct handwashing procedures
* Be able to demonstrate their ability to use correct handwashing procedures
* Be aware of other ways to reduce worm infestation

|  |
| --- |
| **Background Information**  Micronutrient malnutrition is not caused by food-related factors alone. Worm infestation is a non-food-related factor that has a direct negative effect on the utilization of nutrients by the human body. Worm infestation is a serious health concern: children who are infected by worms are 1.5 times more likely to be malnourished compared to non-infected children (Guan & Han, 2019).  Internal parasites are introduced to the body primarily through human hands. They then multiply in our organs and compete with the human body for the nutrients in the foods consumed. In addition to the serious nutrition implications, some parasites cause nausea, loss of appetite, general body malaise, loss of blood/anaemia, paleness and malnutrition.  School-age children in developing countries, including Kenya, are very susceptible to worm infestation, having the highest rates compared to other age groups. Different worm species have different infestation prevalence rate in different parts of the country. A study conducted in schools in Nandi, Kenya shows a prevalence of between 42-73% of Ascaris, 16-38% trichuriasis and 6-41% for hookworm.  Although health and sanitation is a topic covered in the science curriculum by the ministry of education in Kenya, there is a need to reinforce these messages, particularly with regards to regular handwashing and deworming. In terms of benefits, handwashing with soap reduces the occurrence of diarrheal diseases by 45% (Center for affordable water and sanitation technology, CAWST 2017); it prevents germs from getting into our body, e.g. the coronavirus. Deworming reduces the burden of worms in the body.  In addition to handwashing, the participants need to understand other hygiene practices like drinking of clean, safe water, washing of fruits and vegetables with clean and safe water before eating, body hygiene, regular and proper use of latrines/toilets, footwear and, general food safety. Some barriers to handwashing have been identified, including lack of clean water and, or facilities, cultural practices, inadequate availability and use of toilets/latrines and footwear. Insufficient knowledge about proper handwashing procedures is also a barrier. |

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| Instructional Session Content  (Educational message and procedures) | Resources and References |
| Introduction 10.00 a.m. to 1.15 p.m.   * Welcome the participants remind them to put the name tags on. * Introduce the topic “Handwashing.” |  |
| * Discussion followed by a demonstration and an activity   Importance of Handwashing   * Is the most effective way of keeping away germs and harmful bacteria from our hands * It prevents the spread of disease and keeps the environment safe and clean. Therefore, reducing infections and micronutrient malnutrition   Activity 1: Demonstrate the spread of germs using Glitter Hand Shake/pepper   1. Put a small amount of loose glitter (or another type of powder than can easily spread on contact) on your hands without the participants knowing. 2. Shake hands with everyone and ask them to shake hands with each other as if they are meeting on the street or at a community gathering. Ask the participants to look at their hands and clothes and see how the glitter has been spread 3. Ask the participants to discuss what diseases can be passed between people when they shake hands (bacteria, parasites and other disease-causing organisms, e.g. the COVID-19 virus) 4. Present the lesson description or learning outcomes   Activity 2: Handwashing - 10.15 a.m. to 1.30 p.m.   * Participants are asked to brainstorm the instances that people should wash their hands * Set up a handwashing demonstration using pepper and soap example.   Procedure   * Invite the students for a handwashing session outside the classroom. * Demonstrate the handwashing process as follows:  1. *Wet your hands with water* 2. *Apply enough soap to cover the wet hands* 3. *Scrub the surfaces of your hands; palm to palm with fingers interlaced* 4. *Put the right palm over the back of the left-hand interlace the fingers and scrub, and vice-versa* 5. *Rotationally rub the left thumb with the right palm and vice-versa.* 6. *Rotationally, rub backwards and forward of your fingers* 7. *Rinse thoroughly with clean water* 8. *Dry wet hands with a paper towel or a single clean cloth, if not available, air dry.*  * Let the participants wash their hands.   Encourage participants to make handwashing facilities using locally available materials, e.g. leaky tins  **Identifying barriers**: What prevents you from washing your hands regularly?   * *Let the participants brainstorm* * *Then discuss the points below* * *Let the participants discuss the solution to each barrier.* * Inadequacy of water * Inadequate or unavailability of handwashing facilities * Lack of money to purchase enough water for home use * Inadequate knowledge of other handwashing alternatives and unavailability of the same * Insufficient knowledge on the severity of the complications related to poor or inadequate handwashing and consequence of the same   How to overcome the barriers?   * Learn the critical instances that require handwashing. * Participants to make handwashing facilities with locally available materials   Key messages   * Regular and timely handwashing and use of latrines/toilets according to the recommended procedures prevent the spread of germs. * Alcohol-based sanitizers can be used as alternatives to handwashing in cases of water unavailability. * Taking deworming medicine twice a year reduces/kills germs that are already in our body, hence improving the body's ability to utilize nutrients from the foods ingested.   Biannual deworming for children 2-12 years is done in areas where soil worm infestation is over 50%  Four critical times for handwashing:   * After defecation, * After changing diapers, * Before preparing food and * Before eating | -Posters are outlining the handwashing  procedure, take-home fliers  -leaky tins/buckets, water, soap/detergent and paper towels. (schools with no taps)  Pepper - pepper represents germs. Soap washes away the germs. |
| Conclusion and wrap up  Thank the participant  Tidy up the demonstration site |  |

**Session 3: MAXIMIZING ZINC AND IRON IN FOODS**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

**Learning Objective(s):**

By the end of the lesson, 90% of the participants should be able to:

* State the importance of practising healthy eating behaviours at the pre-adolescent stage and throughout the lifespan.
* Identify key food sources of zinc and iron
* Identify the food preparation methods that protect both zinc and iron
* Identify the difference in texture, palatability and nutritional quality between soaked versus unsoaked maize and beans.

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| **Background Information**  Micronutrients are minerals and vitamins needed by the body in small amounts. They are not produced in the body and therefore, must be provided in the diet. If they are consumed in inadequate amounts in the diet, serious outcomes such as micronutrient deficiencies are likely to occur. Deficiencies can’t lead to reduced cognitive development and reduced learning ability.  **Iron** and **zinc** deficiencies are among the micronutrient deficiencies most likely to affect school-age children in Kenya. Most school children consume maize and beans regularly; however, the recommended practices that preserve iron and zinc in the maize and beans meals such as soaking are rarely applied. These children, therefore, are more susceptible to micronutrient deficiencies. Inadequate knowledge of dietary sources of these micronutrients and the recommended food preparation practices are barriers to reducing the deficiencies.  Activities in this section focus on enhancing children's knowledge of food preparation practices that will preserve the iron and zinc content of regular foods; thereby increasing the utilization of zinc and iron nutrients by the body and reducing the risk of their deficiencies. |

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| Instructional Session Content  (Educational message and procedures) | Resources and References |
| Introduction 10.00 a.m. to 10.10 a.m.   * Welcome participants to the class * Participants to put their name tags on the desks |  |
| ZINC AND IRON MATTER!  Time: 10.10 a.m. to 12.30 pm  Presentation followed by an activity and discussion  ZINC  Zinc deficiency is one of the most common micronutrient deficiency affecting rural dwellers, including men, preschool children and school-age children in Kenya. School children are particularly susceptible to zinc deficiency; affecting almost 81 out of every 100 school-age children (Micronutrient survey, 2011). This is a concern, since the intake of zinc has several important functions in the body, including:   * Promoting growth and development; sexual maturation and reproduction * Maintaining and healing of tissues such as wounds * Improving the functioning of the immune system * Metabolizing of macronutrients, providing the body with energy * Enhancing the sense of taste * Enhancing the utilization of vitamin, A in the body   When zinc deficiency happens, serious effects occur such as:   * Fatigue * May have difficulty concentrating in class * Have a poor problem-solving ability and * Be more likely to become ill because they can’t fight infections   Therefore, school children should be aware of the benefits of consuming sufficient sources of zinc and increasing utilization of zinc.  Good food sources of zinc include   * Eggs * Milk and other dairy products * Beef * Beans, seeds and other legumes * Whole grains   Food preparation practices that protect and promote the utilization of iron and zinc in the body.  This curriculum covers the following practices   * Fermentation * Soaking (will be discussed after the iron lesson) * Addition of animal sources of iron * Enrichment of plant-based iron sources with vitamin C foods, e.g. the enriched githeri and or consumption of fruits after meals   Let’s be Food Scientists:  Activity 1. The Fermentation of cereals   * Fermentation promotes the multiplication of beneficial bacteria (probiotics) * When we drink fermented porridge, we add good bacteria that improve the health of our digestive system * Make digestion easy * The fermentation process breaks down phytic acid, make iron, zinc and other minerals available for the body * Fermented foods support the immune system   Instructions   * Teacher to explain the fermentation process to the participants using the procedure outlined below. * Teacher to prepare fermented and unfermented porridge and carry to the lesson for participants to taste. * Ask participants to make fermented porridge with the help of their parents for home consumption. * Do a recap of this lesson at the beginning of the next class and confirm if they did the fermentation assignment.   Procedure   * *Mix 236g of flour with 500ml of water* * *Set it aside in a warm place overnight (for about 8 to 12hours or more).* * *Boil half the quantity of water used to ferment (250ml), add the fermented mixture to it as you stir continuously,* * *Once it comes to boil, leave it to simmer for five minutes.* * *Add sugar and lemon if desired* * *Serve when ready*   IRON   * Prevalence of iron deficiency anaemia among school-age children is 4.9 %; in every 100 school-age children, five are suffering from iron deficiency anaemia. * Iron needs are usually at their peak during adolescence due to rapid growth. Girls are especially susceptible to iron deficiency due to the losses in menses and especially if the losses are not restored by consuming sufficient iron in the diet. * Iron needs are also higher if there are infectious diseases such as HIV, malaria, and parasitic infections that can cause iron loss. * There are health benefits that come from consuming foods like cereals and legumes that have zinc, iron, and other nutrients. * Different grains and cereals are available in the community. However, maize and beans are the most common sources that are consumed regularly. It is very important to learn how to preserve and enhance the absorption of from plant source. This is particularly important because people who live in rural areas consume plant sources regularly.   Iron has several important functions in the body such as   * Helps in the formation of haemoglobin that transports oxygen in the blood. * Promotes growth and intellectual development; functioning of the brain, muscles, and the immune system. It also improves academic performance. * Prevents anaemia. * Allows the conversion of beta-carotene to vitamin A in the body. * Helps in the synthesis of collagen. * It is a component of many enzymes required for the metabolism of glucose and fatty acids.   When iron deficiency happens, serious results can occur: students who are vulnerable because of high needs and low iron intake could develop severe symptoms such as   * Being very tired, * Dizzy, * Pale and, * Being more susceptible to infections.   Therefore, children should be aware of the benefits of consuming sufficient sources of iron and ways of increasing its utilization in the body.  Note:   * The iron from plant foods (non-haem iron) is not readily absorbed. Therefore, non-haem sources such as grains and beans should be consumed with vitamin C or animal sources in the diet to increase the availability in the body. * The amount of iron absorbed in the body when one consumes non-haem sources with vitamin C increase; however, the absorption varies with vitamin C dosage/amounts in the food. * Tea and coffee contain anti-nutrients (e.g. tannins) that decrease absorption of iron. Therefore, it is best to avoid tea and coffee for 1-2 hours when consuming foods containing non-haem iron such as githeri. * In Kenya, tea consumption with meals is very common even among children. Therefore, cultural practices could be a barrier to adopting this recommended practice of avoiding tea at mealtime. Encourage tea intake in between meals   Barriers:  The Kenya guidelines recommend a 1.5:1 ratio of maize to beans when preparing githeri. This is sometimes not achieved due to the price of beans which is higher than maize. Alternatives to beans like green grams and other legumes that are less costly can also be used in place of beans to achieve this ratio.  Good sources of iron   * Organ meats, e.g., liver, kidneys * Beans, lentils, green grams, soya beans * Whole grains * Green leafy vegetable, e.g., kales, spinach, amaranth leaves * Fish   Activity 2: The soaking of legumes and cereals  Time: 10.30 am to 12.30 pm  Key message  Soaking your maize and beans makes them more nutritious and digestible. It also saves on fuel and cooking time.   * Soaking of cereals and legumes before cooking softens them and hence reduces cooking time. This depends on the variety, storage and soaking duration of the legume or grain. It reduces cooking time by 50% * Soaking also reduces anti-nutrients (phytates and oxalates) in beans, and maize (legumes and cereals); therefore, it makes iron and zinc available for the body to utilize. * Soaking reduces gases in beans and other legumes. Therefore, makes it friendly for the stomach. * The whole maize /maize floor is more nutritious than polished maize/sifted unfortified flours. * Time of soaking varies depending on the type of legume and cereal, i.e., dry maize and beans should be soaked for 8-12 hours. Others like green grams take a shorter time to cook and requires a shorter soaking time of 1-2 hours   Procedure:   * *Organize the participants into groups and assign them roles (group leader, reporter)* * *Each group will be provided with two samples each of soaked and unsoaked beans and maize* * *The instructors to guide the participants through the texture and palatability assessment process using provided assessment forms.* | **Definition of terms**  **Fermentation** is the breakdown of carbohydrates with natural yeasts into simple sugars.  **Phytates** are substances found in nuts, whole grains, and seeds that bind iron and zinc, making them partially unavailable for the body.  **Cereals** are plants that give dry foods like grains, e.g. maize, sorghum, rice, wheat  **Legumes** are plants that have fruits as pods and swellings in their roots called nodules. E.g., beans, peas and green grams  Laminated images of food sources of zinc  **Ingredients**  1 ¾ cups (236 g) of porridge flour, 7cups of water (1500 ml), cooking stick, empty jar  Laminated images of iron food sources  Simple assessment forms to rate texture (“soft”, “medium”, “hard”) and palatability (taste as “poor” or “excellent”) |
| Conclusion and wrap up  Review the key messages and give a summary  Thank participants and the teacher  Tidy up the room and collect the name tags |  |

**Session 4: FILL YOUR PLATE WITH COLOUR**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

**Learning Objective(s)**

**After completion, 90% of the participants will**

* Understand the reasons for the inclusion of vegetables as a strategy to improve micronutrient intake
* Be able to identify key food sources of vitamin A and vitamin C and which vegetables should, therefore, be added to githeri and
* Participants will understand the importance of cooking vegetables for a short time, especially dark greens.

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| **Background Information**  Regular consumption of fruits and or vegetables is the best way to improve vitamin A and C intake. However, this has been a challenge since most school-age children eat two meals at school and only one meal at home. The regular meals prepared at schools without gardens are typically githeri without vegetables, and porridge (made of maize flour) as available supplies are based on affordability by the parents. Culturally, low-income families do not consider fruits as part of a meal; therefore, they are rarely budgeted for and rarely consumed at home and school. Therefore, it is important to teach about the sources, importance and benefits of fruit intake. However, a financial constraint remains a great barrier to the regular consumption of fruits.  Learning about the importance of regular consumption of fruits and or vegetables as sources of various vitamins, especially vitamin A and C, is critical. The enhancement of the iron content of regular foods like githeri through the addition of locally available vegetables like, amaranth, pumpkin leaves, carrots, onions and tomatoes, etc., would significantly improve the micronutrient content. |

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| Instructional Session Content  (Educational message and procedures) | Resources and References |
| Introduction: 3.00 p.m. to 3.05 p.m.  Welcome participants to the class |  |
| Body   * Presentation followed by an activity and discussion   Time: 3.05 pm to 3.15 pm  Teacher information  VITAMIN A  Vitamin A deficiency is also a serious problem across all age groups in Kenya. In every 100 school-age children, four are suffering from vitamin A deficiency (VAD) and 34 are at risk of becoming VAD deficient (marginal VAD).  Importance of vitamin A   * Improves vision, * Strengthens body immunity hence prevents one from getting an infection * Fastens recovery from disease infections (strengthens body immunity).   Vitamin A deficiency could cause:   * Night blindness * Impaired immunity * Increased susceptibility to infections * Longer recovery time in case of sickness   Good sources of vitamin A  (refer to the laminated images)   * Orange/yellow vegetables like pumpkin squash, orange flesh sweet potatoes. * Milk and milk products * Eggs * Green leafy vegetables like kales, spinach, amaranth, stinging nettle, pumpkin leaves and black nightshade * Carrots * Mangoes * Oranges * Pawpaw   VITAMIN C  Since Vitamin C improves the absorption of iron in the body, insufficient consumption would contribute to the prevalence of iron deficiency anaemia. It is therefore important for children to consume sources of vitamin C with cereals and grains where iron is poorly absorbed.  Importance of vitamin C   * Remember that we discussed that vitamin C enhances absorption of iron in the body: eating fruit at the same meal with githeri helps. * Fastens wound healing and * Prevents scurvy * Lowers the risk of heart disease   Vitamin C deficiency can lead to serious outcomes, including   * Scurvy * Poor wound healing * Reduced absorption of iron   Sources of vitamin C  Sources vary with season.  (refer to the laminated images)  Examples of Vitamin C rich food and their vitamin C content  (FAO &Government of Kenya, 2018).   |  |  | | --- | --- | | **Source** | **Amount (mg/100g)** | | Spinach | 30 | | Potatoes | 20 | | Tomatoes | 10 | | Watermelon | 10 | | Banana | 9 | | Carrot | 9 | | Apples | 6 | | Oranges | 50 | | Strawberry | 60 | | Green beans | 16 | |  |  |   Cooking Methods to Preserve Vitamin C   * Do not boil green vegetables such as kales or spinach in water for more than 10 minutes; this will prevent water-soluble vitamins like vitamin C and folate from leaching into the water, which is usually discarded and not consumed. * Vitamin C is easily destroyed by excess heat; therefore, it is important to add green vegetables to githeri in the final 10 minutes of cooking. This practice will preserve vitamin C and other heat-sensitive vitamins like thiamine (B1) * Do not add sodium bicarbonate to maize and beans when soaking or to green vegetables to preserve colour and to soften them. Sodium bicarbonate destroys vitamin C in foods   % Vitamin C lost during cooking at 480C   |  |  |  |  | | --- | --- | --- | --- | | Cooking | % Vitamin C lost in 5 mins | % Vitamin C lost in 15 mins | % Vitamin C lost in 30 mins | | Vegetable | 9.94% | 29.94% | 60% |   Key message   * To increase the absorption of fat-soluble vitamins; A and others (D, E and K), foods (super githeri) should be fried with oil or accompanied by foods rich in fats and oils * Githeri and other foods like porridge can also be enriched with fortified margarine, grated carrots, orange-fleshed sweet potatoes and milk to increase Vitamin A, depending on availability. * Cost of fortified oil may be a barrier to using it.   If so, children can be encouraged to consume other sources of vitamin A such as green and orange vegetables.  NB. You can always enhance your food in a culturally accepted way. i.e. for the Luo community, cook the food items in separate pots then serve them in one plate or, reduce the number of vegetables included, in the vegetable but make sure that each vegetable category is represented (yellow/green).  Activity 1: The Preparation of super githeri (Nyoyo)    Procedure:   * Organize the participants into three groups for githeri and two groups for fruit salad. Numbers will depend on the class number. Assign roles such as preparing for soaking, boiling, chopping of vegetables or fruits and frying.   NB: Remember what we learnt in the handwashing lesson.  Soaking and cooking of super Nyoyo  Nyoyo (fried maize and beans with vegetable) preparation 10hours   * *Work with students to wash, sort and soak the maize and beans with clean water for about 8 hours(overnight)* * *Measure the required amount of maize and beans and set aside to soak in 18 cups of water for 8-12 hours* * *Drain and discard the water* * *Put aside 1/8 of the soaked maize and beans for comparison with the unsoaked maize and beans later* * *Put the soaked maize and beans mixture and let it boil until when it is soft (edible)-about three hours* * *Put aside ¼ of the plain githeri for comparison with the super githeri later* * *Chop the green leafy vegetables, onions, carrots, and tomatoes* * *Put the onion into a pot with cooking oils, cook the onion until golden brown, add tomatoes (if available) and let it cook to a paste* * *Add the remaining plain githeri to the fried onions and tomatoes and mix,* * *Add chopped green vegetables and any other available vegetable like carrots and let them cook for the final 10 minutes.* * *Also, add salt to taste and mix* * *Remove and serve*   Nutrition data per 100g of a recipe of plain githeri and supper githeri:   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | **Vitamin A** | **Vitamin C** | **Zinc** | **Iron** | | Nyoyo  (fried maize and beans mixture) per 100g of recipe | 2 mcg | 0.8mcg | 1.32mcg | 2.2mg | | Super nyoyo (Fried nyoyo and sukuma wiki) per 100g of recipe | **122mcg** | **90.1mcg** | **1.74mcg** | **4.5mcg** |  * Each group should have three samples 1) soaked and unsoaked maize and beans 2) plain githeri and 3) super githeri for sensory testing * The research assistants to guide the participants through the tasting assessment process   Barriers to the consumption of fruits  Economically, fruits are considered less important compared to the main meals. The majority of people in Kenya work hard to get food every day and fruits are effective in satisfying hunger. These cultural attitudes could act as a barrier to consuming fruit after meals. Introducing fruit as a dessert that could reduce the risk of iron deficiency could change people’s attitudes so that they see fruit as a benefit. | Laminated images of vitamin A food sources,  take-home fliers  Flip charts, marker pens  Laminated images of foods rich in vitamin C  **Ingredients**  1.5 kg of dry maize 4 ¼ cups (740 g) kidney beans, red, dry  21 ¾ cups (4728 g) water 1 onion, red-skinned, raw, unpeeled (283 g)  1 1/8 cups (173 g) cooking fat.  4 ½ tsp. (22 g) salt, iodized  Raw sukuma wiki leaves (267 g)  Cooked githeri, cooked super githeri,  Carrots, kales/ spinach, onions tomatoes, salt, oils, avocado, disposable plates, and spoons  Simple assessment forms to rate texture and palatability (participants to describe the taste as poor or excellent) |
| Conclusion and wrap up   * Home assignment   Ask each participant to visit their home  kitchen garden and take note of  the crops grown in it before the  next class.   * Thank the participants * Inform them of the next class * Tidy up the classroom |  |

**Session 5: THE KITCHEN’S TOP SECRET**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

**Learning Objective(s):**

* Participants will understand the various types of kitchen gardens and the types of vegetables grown in a kitchen garden.
* The participants will understand the importance of a kitchen garden in reducing the seriousness of micronutrient deficiencies.
* Participants will understand the connection between kitchen gardening and diet diversity

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| **Background Information**  **Kitchen gardening** is the growing of crops, especially fruits and vegetables, in a small piece of land at school and or home. It is one of the strategies that improve regular access to a variety of fresh, nutrient-rich vegetables among the rural Kenyan population who feed directly from the farm. Therefore, it’s the most cost-effective way of reducing micronutrient malnutrition in rural Kenya.  We have discussed the importance of consuming enough iron, zinc, vitamin A and C in the previous lessons. We have learnt that vegetables and fruits that are important sources of vitamins, and they can help in improving the utilization of iron in foods like githeri.  Knowledge of the different types of existing kitchen gardens and the crops /vegetables that can be grown in a kitchen garden is essential to school-age children in Kenya. It is important to spark the interest of participants to get involved in kitchen gardening activities at school and home.  The purpose of this lesson on kitchen gardening is to make participants aware of the importance of producing nutrient-rich vegetables as a way to improve accessibility to healthy foods and reduce the risk of vitamin deficiencies. |

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| Instructional Session Content  (Educational message and procedures) | Resources and References |
| Introduction 3.00 to 3.10 pm   * Welcome the participants and distribute the name tags. * Introduce the FHF guest speaker * Introduce the topic |  |
| 3.15 pm to 4.30 pm   * Presentation followed by quiz and group work   Definition   * A kitchen garden is a piece of land or growing bag at school and or home where various types of vegetables are grown for home or school consumption. * Examples of crops in a healthy kitchen garden * Kales * Spinach * Carrots * pumpkin * Amaranth * Onions * Tomatoes * Coriander * Benefits of a kitchen garden * Ensures regular access to diverse nutritious vegetables * Reduces expenditure on vegetables, * It can be a source of income if the surplus produce is sold. * Explain the various types of kitchen gardens, including growing bags, use of containers, or growing directly on land.   Activity 1. Group work  Designing a kitchen garden    Procedure   * *Organize participants into groups* * *Each group should design a kitchen garden plan with the guidance of the research team and FHF guest speaker (sack gardening and on land)* * *Group answers to be presented by one representative of their choice.*   *Note: Identify one child with a healthy kitchen garden at home, and then organize for a visit to the kitchen garden for further learning*. | Laminated pictures of different types of kitchen gardens e.g.  The growing bags/sack gardening, etc., masking tape, flip chart, marker pens, take-home fliers  An outline of a kitchen garden space  Growing bags /sacks |
| Conclusion and wrap up     * Welcome questions from participants, answer them/let other participants answer/ FHF guest speaker may have contributions, thank the guest speaker, participants, and encourage participants to start kitchen gardens at home. * Inform participants of the next class. * Gather name tags and photos |  |

**Session 6: IT IS A WRAP!**

Priority Population: Grade six children

Community Group: Ndhiwa, Kenya

Length of session: 1 hour

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| Instructional Session Content  (Educational message and procedures) | Resources and References  (Keep them linked with the appropriate activity) |
| Introduction 3.00 pm to 3.10 pm  Welcome participants to the session  Pin the FFQ posters on the classroom wall | FFQ posters, Masking tape. |
| Time: 3.15 pm to 4.30 pm   * Post assessment evaluation   Key message  The post-assessment aims to assess any improvement following the four-week nutrition education program. Assure the participants that it is not a competition.  The posters for different lessons should remain on the walls of the classroom permanently after the pre and post-assessments for them to refer to during other times outside nutrition class to increase contact with information and memory.  Procedure.   * *Post-intervention assessment* * *Research assistants to provide support to participants as needed* | Pens, post-assessment survey questionnaires |
| Conclusion and wrap up   * Collect the pre-assessment questionnaires * Appreciate the participants, the head teacher, and the classroom teacher for their support. |  |

## Appendix 5: The Healthy Foods Evaluation

**Date…………………………………. Group Name……………………………**

**Sensory Evaluation of Porridge**

In front of you are two samples of porridge. Taste each sample and tick your rating for the taste attribute

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| --- | --- |
|  | **How is the taste of the porridge?** |
| Sample 1 | Not very good  Okay  Really good  Bad  Delicious |
| Sample 2 | Bad  Not very good  Okay  Really good  Delicious |

**Sensory Evaluation of Maize and Beans Mixture**

In front of you are two samples maize and beans mixture. Touch/feel/Bite each sample and tick your rating for the texture attribute

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **How is the texture of the maize and beans mixture?** | | | | |
| **Very soft** | **Soft** | **moderately soft** | **slightly soft** | **Hard** |
| Sample 1 |  |  |  |  |  |
| Sample 2 |  |  |  |  |  |

**Sensory Evaluation of Nyoyo**

In front of you are two samples of githeri. Taste each sample and tick your rating for the taste.

|  |  |
| --- | --- |
|  | **How is the taste of the Nyoyo** |
| Sample 1 | Bad  Good  Not very good  Very good  Excellent |
| Sample 2 | Bad  Not very good  Good  Very good  Excellent |

## Appendix 6: Project Evaluation Form

https://lh5.googleusercontent.com/981nefdExrTNRMpM2-dbFLND94Rg1STe02J9-spNE-JMw35EiiH8JPLdg2hIrQg6QdFVHzgUaUffv8bCXUGSJHRFiBDCXh_3EY7HFwjwPpRAZUjYHRE-dNf3aJvS4fna7ObO2MPV

**A Food-Based Nutrition Learning Program for School Children**

We would like to know how you feel about the learning program that you have been attending over these past six weeks. Please answer by circling the yellow face that best represents how you feel. Do not put your name on the paper, as your answers will be private.

1. How would you describe your overall experience with the program?

https://lh5.googleusercontent.com/ihjK34AJcXdyBc4iMg1XXGRNlSc3oCvv9J8zu4lPZkmMyOwo4pBG84XflqiV38n_jdEscajJ7sm5js-DDR3zytzcznxZluqGmKkCZQehUc02J9diV4ercfpcbeQdsExRsdhEUP5l

2. How would you describe the program lesson materials and flyers (handouts)? https://lh4.googleusercontent.com/6eksENpsVgEpT9VtXs1TnERNUVaNro9-iHlC0RGYXFSI-pcMm_yY4zUv804GYhQ5drg-BiBz6s7SQpnLotcgQ3jho6e6AgsheaM1M1rofDD9q9SSYdsg4O7EkPx4_wqe59sQkDIH

3. How would you describe the activities that you participated in?

https://lh4.googleusercontent.com/R8EFtXT9PoWCY9Ag50MGsztyx_3ymLH4AJNr-cNwa6SWCxH6a31I1dsg7QgHW18r6DgANbVRe05OTlmyi6R6N_Jurl8qBo14TbaIb1yvCzZCP3br4_dl2Lt1xaivSfHc-Q23pHRl

4. How would you describe the instructor of the program?

https://lh6.googleusercontent.com/evKP9JQGMIHROzslhb6lb7EQq5-SsiSpRwlvqatLPug1XsyNz-SY-7Fvitt7mOKI5Mrkl1wXTx-XtKA_Gae5gAyownH64yorW36MDU7l7nNA18YDrx0bEPKAJZXtvaht_KT_lfeU

1. What should we continue doing with the program?

6. What should we change about the program, if anything?

Thank you for doing this survey

## 

## Appendix 7: Debriefing Script

At the end of the 6-week food-based nutrition education program, students will complete the 'post-test' questionnaire. We will thank the students for their participation and present them with a certificate of participation and a pencil. Since there is no deception involved in this study, we will tell the students who received the program the following: Thank you for participating in our research study. We hope that you have enjoyed participating in and learning new things about how to prepare food that will help you to be healthy. We will take all of the information from all of the questionnaires and enter it into a computer. Your names will not be included, and all information will be kept private. We will look at our results and determine the schools that received the nutrition program learned more about nutrition and food and were more likely to eat the foods that we recommended in the lessons than children who did not receive the program. Now that the study is over, we will offer the nutrition program to the children who did not receive it over the past 8 weeks so that everyone can learn about nutrition. Once we finish looking at our results, we will provide a summary to your community learning program teachers (or schools, depending on whether schools reopen or not) and will make a presentation on the results that you will be invited to. Remember that no names or identifying information will be included in the report or in the presentation. Thanks again!

For the groups not participating in the program, we will use the following script: Thank you for participating in our research study. We appreciate your filling out the questionnaires for us. We will take all of the information from all of the questionnaires and enter it into a computer. Your names will not be included, and all information will be kept private. We will look at our results and determine the children who received a nutrition program and learned more about nutrition and food and were more likely to eat the foods that we recommended in the lessons than children who did not receive the program, which includes your group. Now that the study is over, we are willing to provide the nutrition program to your group if you wish to participate. Once we finish looking at our results, we will provide a summary to your community learning program teachers (or schools, depending on whether schools reopen or not). Remember that no names or identifying information will be included in the report or in the presentation. Thanks again!