筑 波 大 学

博 士（医学）学 位 論 文

Effects of Maternal Nutrition Education on Children's Nutrition and Health in Nairobi, Kenya

(ケニアのナイロビにおける母親への栄養教育が子どもの栄養と健康に及ぼす影響)

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Summary

Introduction: Inadequate maternal nutrition knowledge on appropriate infant feeding may increase poor child health outcomes. Moreover, urban slums may pose risk to child health due to poverty, food insecurity, poor sanitation and high infections. As a result, African Population and Health Research Center (APHRC) conducted a home-based maternal nutrition education and counselling from 2012-2015. However, it's not well known if mothers living in urban slums can adopt and practice healthy behaviours for longer because of other underlying risks.

Objective: The main purpose was to evaluate the effect of maternal nutrition education and counselling on child's birth outcomes, linear growth from birth to five years and prevalence of anaemia at the fifth year, while assessing determinants of these health outcomes.

Methodology and analysis: This was a follow-up study of a randomized controlled trial (RCT) which was conducted in two urban slums of Nairobi, Kenya. A total of 1,555 pregnant women were recruited during pregnancy. However, about 1001 mother-child pairs remained in this cohort at birth. Data was collected twice during pregnancy and when the infants were 1, 4, 7, 9, 11 and 13 months old. A total of 438 mother-child pairs participated in the 2018 follow-up when the average age of the children was 55 months. The effects of the intervention on child birth outcomes, anaemia prevalence and linear growth was tested by constructing multivariate logistic regression and linear fixed effect models with adjustment of confounders.

Main results: The mean (SD) gestation age at birth of all the children was 38.4 (3.9) weeks and the mean birth weight was 3.24 (0.52) kg. A significantly higher proportion of preterm and low birth weight babies were born in the control (27.6%, 6.7% respectively) than in the intervention

group (23.2%, 2.5% respectively). Moreover, child mean (SD) length one month after birth was 53.6 (4.2) with more stunted children in the control group, 124 (27.2 %), as compared to the intervention group, 93 (23.9 %).

Subsequently, length-for-age z-scores decreased from birth to the 13th month, mean (SD) -1.42 (2.04), with the control group (33.5%) reporting a significantly higher prevalence of stunting than the intervention group (28.6%). Conversely, the scores increased in the 55th month, mean (SD) -0.89 (1.04), with significantly more males stunted in the control group (16.5%) than in the intervention group (8.3%). At the mean (SD) age of 55.9±5.3 months, their mean (SD) haemoglobin was 10.71± 1.47 g/dL. A total of 33.9% had mild anaemia, 24.7% moderate and 1.2% severe with similar proportions in both study groups.

Overall the intervention group had lower risk for low birth weight, preterm delivery and stunting, while children born in Korogocho slums, maternal mid-upper arm circumference of <23cm, mother's stature of <154 cm, child often vomiting/regurgitating food, being a male child, early weaning, absence of a home toilet, fully immunized child, non-anaemic mother, were some of the factors that increased the risk of poor birth and nutrition outcomes in children.

Discussion: The present study findings report a significant reduction of low birth weight, preterm births and stunting among under five-year-olds through offering personalized home-based nutrition education and counselling. Possibly, the intervention augmented maternal nutrition knowledge as demonstrated by better nutrition, good hygienic practices and adequate child feeding practices among the intervention group. Stunting prevalence was high from birth. Previous studies indicate that 20% of stunting can be attributed to small for gestational age hence, need to initiate nutrition interventions prenatally. Additionally, a high prevalence of anaemia was observed at the fifth year. The prevalence was above 40%, a cut off considered as a severe public health problem as classified by WHO.

Extant findings report that nutrition education and counselling was associated with an improvement in pregnant women's diet by increasing their protein and calorie intake, increased child head circumference and birth weight, improved infant and young child feeding practices (IYCF). However, studies reporting the intervention effect on stunting and reduction of anaemia are inconclusive. Previous studies suggest that the contradictory findings are likely to emanate from differences in the duration and intensity of the nutrition counselling provided, the different set-ups for delivering education messages, mode of delivering nutrition education messages, differences in food security status and other underlying risk factors in the study areas. Besides, the present study identified predictors of poor child nutrition outcomes. Therefore, it is important to consider all these factors when implementing such interventions.

Conclusion: Findings from the present study proved that training community health care workers to deliver a personalized home-based nutrition education and counselling during antenatal and postnatal period was associated with an improvement in pregnant women's nutrition status, improved child birth outcomes and reduced stunting among under-five years. Long-term benefits of this intervention on children's health need to be elucidated. This finding demonstrates the potential effectiveness of actively engaging trained community health workers under the community health strategy to promote optimal antenatal and postnatal care services, especially in underserved settings such as among the urban poor populations.

Table of Contents

List of Tables

List of Figures

Abbreviations

ANC	Antenatal care
APHRC	African Population and Health Research Center
BAZ	Body-mass-index for Age Z-scores
BFI	Baby Friendly Hospitals
BMI	Body Mass Index
BAZ	Body mass index (BMI)-for-age
CDC	Centers for Disease Control and Prevention
CF	Complementary Feeding
CHWs	Community Health Workers
CS	Caesarean Section
DALYs	Disability Adjusted Years
EBF	Exclusive Breastfeeding
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
GA	Gestational age
HAZ	Height-for-age
Hb	Haemoglobin
IDA	Iron Deficiency Anaemia
IUGR	Intrauterine Growth Restriction
KEMRI	Kenya Medical Research Institute
KDHS	Kenya demographic national survey

KNH	Kenyatta National Hospital
KNH-UoN ERC	Kenyatta National Hospital/University of Nairobi Ethics and Research Committee
LAZ	Length-for-age
LBW	Low Birth Weight
LMICs	Low and Middle Income Countries
MIYCN	Maternal Infant and Young Child Nutrition
MUAC	Mid-Upper-Arm-Circumference
NEC	Nutrition Education and counselling
NUHDSS	Nairobi Urban Health and Demographic Surveillance System
ODK	Open Data Kit
PEM	Protein Energy Malnutrition
RCT	Randomized Controlled Trial
SDGs	Sustainable Development Goals
SES	Socio-economic Status
SSA	Sub-Saharan Africa
SPSS	Statistical Package for the Social Sciences
UN	United Nations
UNICEF	United Nations International Emergency Child's Fund.
WASH	Water, Sanitation, and Hygiene
WHZ	Weight-for-height
WHO	World Health Organization

Definition of Terms

Complementary feeding: this is the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants so that other foods and liquids are introduced, along with breast milk or breastmilk substitutes (WHO, 2002).

Community health strategy: introduced in Kenya under the essential package for health to improve the health status of Kenyan communities through the initiation and implementation of life-cycle focused health actions at level 1 (household and community level).

Personalized nutrition education and counselling: involves an individualized/patient-centred communication through as interactive process focusing on the need of diet modification with messages tailored to the individual's socioeconomic status and needs.

Protein energy malnutrition: A cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions.

Stunting: refers to a child who is too short for his or her age, low height-for-age (< –2 SD from median height for age of reference population). Also known as chronic malnutrition

Wasting: refers to a child who is too thin for his or her height, low weight-for-height (< –2 SD from median weight for height of reference population). Wasting is the result of recent rapid weight loss or the failure to gain weight. Also known as acute malnutrition.

Underweight: low weight-for-age, (< –2 SD from median weight for age of reference population) a child can be either thin or short for his/her age.

CHAPTER 1: General Introduction

1.1 Child nutrition

Child nutrition is a major global public health agenda because it's one of the most important factor in a child's health, growth and development especially during the first years of life [1]. Sub-optimal nutrition during this period have detrimental irreversible consequences to the affected child. As a result, the sustainable development goal (SDG) 3 underscore this importance by calling for to an end preventable deaths of infants and under 5 children [2]. Moreover, five series are published in the lancet covering maternal and child undernutrition, nutrition-specific and nutrition-sensitive interventions proven to improve child nutrition. All series identified that good nutrition and healthy growth starting from conception, during pregnancy and in the first 2 years of life (1000 days) have lasting benefits throughout life [3].

1.2 Birth outcomes

Birth outcomes such as low birth weight (LBW), preterm delivery and stunting at birth continue to be a major public health problem. Two thirds of LBW may result from preterm delivery while one third is associated with intrauterine growth restriction (IUGR) resulting to small-for-gestational-age at term [4,5]. The aforementioned poor birth outcomes may increase the risk of neonatal/infant morbidity and mortality with a global record of 80% neonatal deaths caused by low birthweight. Further, if the child survives, they may develop other long lasting consequences such as higher risk of morbidity, long-term impaired growth and developmental, physical ill health, neurological impairment and onset of adult-chronic conditions such as cardiovascular disease [6]. Half of the long-term morbidity in developed countries is caused by preterm delivery. Low-income countries report highest rates of these poor birth outcomes. Poor socio-demographic and socio-economic factors e.g. low income, less educated women, and environmental factors such as women living in highly polluted and unsanitary environments are well documented risks of poor birth outcomes [7,8]. A recent study reported that poor childhood experiences or high levels of childhood adversities were associated with poor birth outcomes [9]. While another study identified higher paternal age as a risk factor for LBW and preterm delivery [10].

1.3 Malnutrition

According to the World Health Organization (WHO), malnutrition is a complex problem whereby there is a deficiency, an imbalance or an excess in one's energy and nutrient intake leading to either undernutrition or over nutrition. There are various forms of child undernutrition such as IUGR leading to LBW or small for gestational age (SGA), micronutrient deficiencies, Protein Energy Malnutrition (PEM) which causes stunting, underweight and wasting. Protein energy malnutrition is the cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions [11]. There are various forms of PEM; malnourished children are classified as stunting (poor linear growth; height-for-age Z score <–2), underweight (low body weight compared with healthy peers, weight-for-age Z score <–2) or wasting (acute weight loss; weight-for-height Z score <–2) [12]. Besides, over nutrition may lead to overweight, obesity and other diet related non-communicable diseases such as diabetes, heart diseases, stroke and cancer.

1.2.1 Global burden of malnutrition

The most recent (2019) report by United Nations International Emergency Child's Fund (UNICEF)/WHO and World Bank estimates a global prevalence of 21.9% (149 million) stunted, 5.9 (40 million) overweight and 7.3% (49.5 million) wasted children as of 2018 [13]. Asia and Africa report majority of the stunted (55%, (81.7million) and 39%, (58.8million), respectively), wasted (33.8 million vs 14 million, respectively), and overweight (18.8 million vs 9.5million) [13] children. According to a report by WHO [14], Sub-Saharan Africa and Asia, account for more than 80% of the 5.3 million under-five deaths which occurred in 2018. Further, childhood malnutrition is the leading cause of under five deaths [15].

Stunting is caused by chronic undernutrition that leads to reduction in child's survival rates since they are more susceptible to illnesses. It also hinders optimal growth and development and prevents maximum brain development, causing poor cognitive abilities later in life, cascading poor school performance, later in life, reduced potential for a nation's development [16-18]. Other forms of malnutrition (wasting and underweight) also have significant effects on a child's growth and development. Wasting which is inadequate weight for height and underweight (inadequate weight for age) accounts for acute undernutrition. This acute malnutrition is associated with high mortality risk and attributed to cause 14.6% of all child deaths [19]. The World Health Assembly came up with a target of 40% reduction in the number of stunted children by 2025 [20]. In addition, the United Nations (UN) committed to "end all forms of malnutrition, by 2025 in their zero-hunger challenge which was launched in 2016. Indicators towards promotion of good nutrition are also highlighted in at least 12 of the 17 Sustainable Development Goals (SDGs) which reflects nutrition's central role in attaining the goals.

1.2.2 Malnutrition in Kenya

Studies conducted in Kenya have reported the prevalence of child birth outcomes, PEM and anaemia. For instance, Kenya showed a slight increase in the prevalence of LBW from 6% to 8% as reported in 2009 and 2014 Kenya Demographic Health Survey (KDHS) respectively KDHS [21,22]. While a significant reduction in the prevalence of stunting was observed from 35% in the 2008-2009 KDHS to 26% in the most recent 2014 KDHS [21,22]. The country prevalence of underweight was 11% and only 4% are wasted. Furthermore, nearly half (43.2%-46%) of preschool children in Kenya have been estimated to be iron deficient [23]. However, studies on effects of maternal nutrition education on these indicators of under-five children nutrition are still limited.

1.2.3 Factors associated with malnutrition

The United Nations International Emergency Child's Fund (UNICEF) **Figure 1.1** and the World Health Organization (WHO) outlines conceptual frameworks on causes and consequences of childhood malnutrition [24,25]. Chronic undernutrition (stunting) is attributable to multifactorial factors emanating from family, household, and environmental factors. For example, household latent poverty and chronic food insecurity compromise adequate complementary feeding. Whereas inadequate breastfeeding practices, protracted infections and other health problems hinders optimal nutrition and growth and increases the risk of chronic malnutrition. Genetics and other family factors such as household size and parity also play a significant role in child nutrition outcomes [24]. Notably, undernutrition is not simply as a result of food insecurity and poverty, since many children from low income families but living in food secure environments still become malnourished because of inadequate knowledge on proper infant and young child feeding practices, poor sanitation and inadequate access to health services.

A world bank report on causes of malnutrition highlights other risk factors such as limited time for mothers to practice appropriate infant care practices because of balancing family time with their occupation. Additionally, inadequate knowledge on proper nutritional practices during pregnancy, the benefits of micronutrients, exclusive breastfeeding and proper infant and young child complementary feeding [26]. A study by Hussein et al. reported a higher prevalence of PEM among children who were not exclusively breastfed (48.6%) as compared to those who were exclusively breastfed (18.9%) for the first six months of life. Low income households reported a PEM prevalence of 69.4%. Maternal illiteracy was also associated with PEM in this study [27].

1.4 Iron Deficiency and anaemia among under-five

Globally, one in four people are affected by anaemia, a significant reduction in haemoglobin concentration, haematocrit, or the number of circulating red blood cells at a level below what is considered normal for age, sex, physiological state, and altitude, without considering the cause of the deficiency [28]. Pregnant women and preschool-age children are at the greatest risk. About 47.4% of pre-school children are affected, with the highest prevalence (67.6%) recorded in sub-Saharan Africa [29,30]. Iron deficiency is a major public health problem among preschool children because iron requirements increase between 6-59 months of age as their growth is rapid [31]. Inadequate intake of iron rich foods is the most prevalent cause of anaemia. Other direct risk factors include intestinal parasites, illnesses and infections such HIV and nutrient interactions leading to iron malabsorption. In addition, maternal income, education level, household size were also indirectly associated with anaemia [23]. Anaemia has adverse health consequences to preschool children such as poor immune function, susceptibility to infections, decreased responsiveness/activity, increase in body tension and fatigue altered cognitive function, impaired motor development and growth, poor school performance and reduced productivity [32].

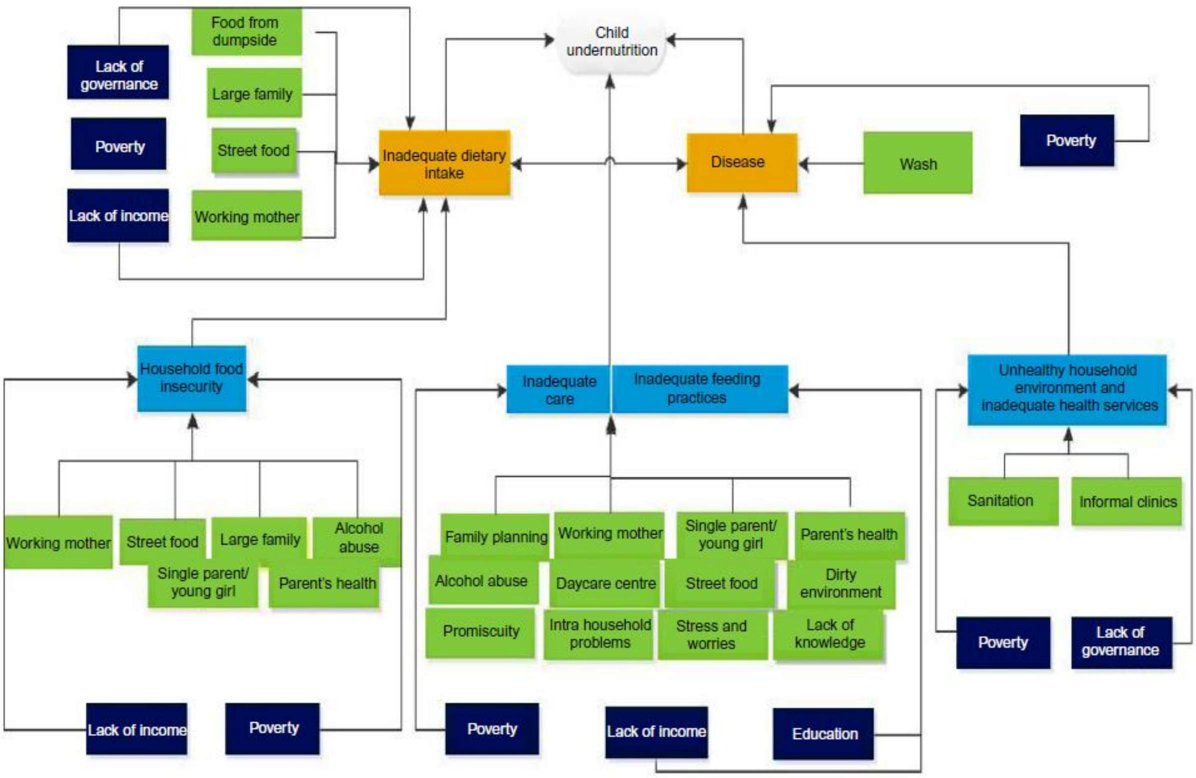

Figure 1. 1 Conceptual framework of perceived causes of undernutrition in urban slums, mapped to the UNICEF conceptual framework [33].

Predictors highlighted in blue and orange were adopted from UNICEF, those highlighted in green were reported by participants of a focused group discussions and key informant interviews held in Nairobi's urban slums.

1.5 Interventions to improve infant and young child nutrition

Various interventions have been tested and proven effective in reducing child malnutrition [34]. A comprehensive systematic review by Bhutta et al. [34] highlights over 25 interventions recommended from conception to infancy and preschool period. This include nutrition specific interventions which address immediate causes of malnutrition and nutrition-sensitive interventions to address underlying causes of malnutrition. Nutrition specific interventions during antenatal and postnatal period are as follows. Firstly, during pregnancy, supplementing pregnant women with iron and folic acid, calcium, multiple micronutrients, iodine through iodized salt, supplements of a balanced energy and protein, maternal deworming, intermittent preventive treatment of malaria, use of insecticide treated bed nets and interventions to reduce tobacco consumption and indoor air pollution are effective in reducing IUGR and improving birth outcomes [34]. However, interventions such as nutrition education and advice, zinc vitamin B6 and vitamin D supplements showed little or no effect to child birth outcomes [34].

Further, during neonatal and infancy period, delayed code clamping, neonatal Vitamin A supplementation through mother's breastmilk, and promotion of exclusive breastfeeding through individual or group counselling for the first 6 months and continued breastfeeding up to two years has been proven to be effective in the reduction of neonatal, infant, young child morbidity and mortality. Breastfeeding is the key strategy for improving child survival. A similar study by Bhutta et al. reports that about 13% of child deaths can be prevented through promotion of breastfeeding [35].

Other interventions effective in improving infant and young child nutrition are: behaviour change communication to improve appropriate/optimal complementary feeding during the critical window period (from birth to 2 years), when growth and development is at the peak. Even though the mother practices adequate breastfeeding, children still develop PEM if a diverse balanced diet is not introduced from 6 months, because breast milk alone is not sufficient to meet the child's nutritional need [36]. Globally, its estimated that among children aged 6-23 months, only 33% receive optimal complementary feeds in terms of frequency, amount and consistency of the diet [37].

Furthermore, interventions to reduce micronutrient deficiencies such as, zinc supplementation or zinc in management of diarrhoea, universal salt iodization, vitamin A and iron supplementation or fortification have been proven effective in reduction of malnutrition and child mortality. For example, 50% of under-five mortality caused by diarrheal diseases and 23% of all-cause mortality among under-fives can be reduced through zin and Vitamin A supplementation, respectively [38]. Moreover, therapeutic management and treatment of severe acute malnutrition (SAM) can reduce 152 000 deaths that occur in health facilities hence, avoid 5 million DALYs [39].

In addition, disease prevention strategies such as promotion of handwashing or proper hygiene and sanitation, deworming, insecticide-treated bed nets and health education are nutrition specific interventions to child malnutrition. Remarkably, about 88% of global diarrhoea cases are caused by unsafe water, poor sanitation and hygienic practices. Further, gastrointestinal infections, food intolerance (lactose), side effects of drugs and environmental enteropathy, common in low income settings can cause diarrhoea. This causes loss of nutrients and reduce child nutrition intake causing malnutrition. Interventions promoting good sanitation and hygienic practices can reduce gastrointestinal infections and diarrhoea thus improve child nutrition status [40]. The above list of interventions is not exhaustive as focus was mainly on nutrition-specific interventions, detailed explanation of nutrition-specific and nutrition-sensitive interventions is already published [34,41,42] .

1.5.1 Personalized nutrition education and counselling intervention

Nutrition education is defined as 'any set of learning experiences designed to facilitate voluntary adoption of eating and other nutrition related behaviour conducive to health and well-being' [43]. While personalized nutrition education and counselling (NEC) involves an individualized/patient-centred communication through an interactive process focusing on the need of diet modification with messages tailored to the individual's socioeconomic status and needs. This is one of the widely-used strategy in health facilities to improve nutrition status of women and their children. NEC is based on WHO antenatal care and postnatal recommendations on healthy diet and practices during pregnancy, appropriate breastfeeding and complementary feeding practices to improve maternal, infant and young child nutrition [44]. More details on personalized nutrition for women, infants, and children can be read in our published book chapter [45].

1.5.2 Findings from previous studies on NEC and gaps in knowledge

A number of systematic reviews have described significant effects of maternal nutritional education and counselling and other complementary feeding interventions on birth and nutrition outcomes of the child [46-52]. However, some studies did not report significant associations between personalized NEC with child anthropometry and morbidity experience among low income populations [53-55]. A recent (2019) systematic review on studies conducted in urban slums from low and middle income countries included two randomized controlled studies on effect of nutrition education for pregnant women on birth outcomes and stunting prevalence. The author reported an inconclusive effect of nutrition education on child's length with very low- to moderate-certainty evidence [56]. These findings are likely to mislead because of limited literature in this regard, while the available literature have eminent weaknesses in the study designs, choice of study areas, and poor implementation of interventions, leading to ineffective nutrition education interventions [53].

For instance, Nikiema et al 2017, conducted a randomized controlled study on effectiveness of facility-based personalized maternal nutrition counselling in improving child growth and morbidity up to 18 months in rural public health centres of Burkina Faso. Mothers in the intervention were counselled on antenatal nutrition, exclusive breastfeeding and complementary feeding from third trimester of pregnancy then quarterly (at 3, 6, 9, 12, 15, or 18) during postpartum as part of health centres' routine activities. However, the intervention did not address hygiene and sanitation, the health care providers in the intervention group were not given additional payment and there was a low attendance rate at the public health facility during the follow-up visits, with a mean of 3.8 visits out of the expected 6 visits, which was similar in both study groups. The intervention was associated with improved Infant and Young Child Feeding (IYCF) practices, and increased child birth weight. However, due to the highlighted study limitations and other confounding factors, there was no effect on children's growth and nutrition status which was assessed at 18 months old [53]. In addition, a similar study in India by Nair et al., which followed-up pregnant women from third trimester to when the child turned 18 months old, did not observe significant differences among intervention and control with regard to mean birthweight, weight-for-height, MUAC, wasting and stunting, all measured at 18 months [57]. However, pregnant women and children in the intervention attained minimum dietary diversity, washed their hands before feeding their children who were less underweight and fewer of them died as compared to children in the control group.

Even though, the above two study's intervention package was almost similar to the present study's, Nikiema's study was individual, patient-centred at the rural public health centres whereas the present study targeted individual mothers in their households in urban slums. Additionally, the present study conducted weekly and monthly home-based personalized NEC and the participation rate was higher unlike Nikiema's study since mothers in the present study scheduled their meeting with the trained Community Health Worker (CHW) based on their availability. Besides, the intervention (NEC) addressed all issues such as maternal prenatal nutrition, exclusive breastfeeding, complementary feeding, household sanitation and hygiene, cultural believes among others [58]. As a result, remarkable improvement was seen in child breastfeeding practices in a publication by Kimani et al. [59]. However, this publication reported on the effect of the intervention on exclusive breastfeeding (EBF) only. Moreover, the prevalence of increased EBF was similar for both study groups (55%). The afterward effects of the same intervention on child nutrition outcomes at one year and 5 years after the intervention ended are not known.

The above referred studies (Nikiema and Nair et al.) among other related studies, assessed the effectiveness of household, community or facility based nutrition counselling on child health outcomes up to 18 or 24 months. Studies that have measured child nutrition outcomes more than 2 years after termination of the intervention reported on lipid profile as the outcome variable. The intervention aimed at reduction of overweight and obesity among children as it focused on improving a healthy eating index [60,61]. Therefore, to the best of my knowledge, there's inadequate data in the literature on the effectiveness of nutrition education alone on maternal and child health with regard to undernutrition and anaemia, after the intervention ended. Most people do not believe that offering nutrition counselling without any material or food support to women from poor environmental settings can yield substantial mid to long-term effects after the intervention is terminated. In addition, most studies report the effect of NEC during and immediately after the completion of the intervention

1.6 Scientific rationale of the study

Researchers have argued that people rarely change behaviour by telling alone due to other underlying conditions such as poverty, illiteracy and inadequate resource [62] while societal economic, and environmental factors confound nutrition and behaviour change [63]. Additionally, interventions produce short-term behaviour change, while maintaining these behaviour change do not appear to have improved significantly over the past years. Therefore, this study will contribute to understanding if personalizing NEC intervention at individual or household level increases its uptake. Besides, women from urban informal settlements have low education, low socio-economic levels and low attendance rate at primary health care centres (PHCs) which might hinder them from maximally benefiting from reading and understanding guides to good Infant and Young Child Feeding (IYCF) resources provided at the PHCs.

Moreover, Nairobi city has one of the largest population of slum dwellers of approximately 1 million inhabitants [64] who are illiterate with high poverty levels as well as poor infrastructure and inadequate health facilities. Other factors include sub-standard housing, inadequate sanitation, insufficient water supply, overcrowding, increase in the incidence of infectious diseases and high rates (12%) of childhood mortality and morbidity than children of the general population and poor health indicators especially for the under-five populations [65]. This provides a good study setting to elucidate the effect of NEC interventions. Consequently, we hypothesize that NEC by APHRC targeting improvement of child health which was based on WHO recommendations for infant and young child feeding practices [66] may have impacted on the pregnant women's knowledge gaps which can translate to adoption of good complementary feeding practices hence positive short, mid to long-term impact of the intervention on child's health. This study will verify this hypothesis for future policy recommendations of either to implement this intervention to improve child health, reduce morbidity and mortality.

1.7 Purpose of the study

Generate information on prevalence of poor birth outcomes, stunting and anaemia among under-five children during and post intervention to report on the midterm effects of the intervention and to provide information towards adopting measures with long lasting effects on improving child nutrition status in low income households.

1.8 Main objective

To evaluate the birth outcomes and mid -term effect of maternal nutrition counselling on child's growth, and morbidity experience during and after the intervention was concluded.

1.8.1 Sub objectives

1) To examine the effect of personalized home based nutrition education and counselling on birth outcomes while reporting on the risk factors associated with the birth outcomes.
2) To determine whether the prevalence of stunting differed between an intervention group and a control group and to identify factors associated with the children's linear growth.
3) To assess the prevalence and determinants of anaemia in urban slums following a nutrition education intervention

1.9 Outline of the thesis

This thesis is structured into five chapters on a personalized nutrition education and counselling and its ultimate effect on the nutrition and well-being of pregnant women, infants, and children. The first chapter, introduction, gives a general background. The author explores the dynamics of infant nutrition and evidence from intervention studies in respect to implementing infant and child nutrition education programs by referring to empirical findings from other personalized nutrition intervention studies. Birth outcomes is presented in the second chapter. The author emphasizes on three poor birth outcomes (low birth weight, preterm delivery and stunting at birth), the effect of the intervention on these birth outcomes and the associated risk factors in the context of the intervention. Chapter three covers child linear growth and stunting prevalence from infancy to five-year-old and the associated risks. Chapter four presents under five-year-old anaemia prevalence and determinants, in the context of this intervention. The three studies use the same cohort, mother-child pairs who participate in the personalized nutrition education intervention. The last chapter (five) is the overall conclusion and recommendation.

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CHAPTER TWO: Determinants of Birth Outcomes in the Context of Maternal Nutrition Education

2.1 Abstract

Inadequate knowledge in maternal nutrition is one of the determinants of poor birth outcome. However, little evidence is available on whether maternal nutrition counselling alone can influence birth outcomes among women of low income. This study assessed the effect of prenatal maternal nutritional counselling on birth outcomes and examine the related risk factors.

A cluster randomized controlled trial was conducted to assess the effectiveness of home-based maternal nutritional counselling on nutritional outcomes, morbidity, breastfeeding, and infant feeding practices by the African Population and Health Research Center in two urban informal settlements of Nairobi. The intervention group received monthly antenatal and nutritional counselling from trained community health volunteers; meanwhile, the control group received routine antenatal care. A total of 1001 participants were included for analysis. Logistic regression was applied to determine associations between low birth weight, preterm births, stunting at birth and covariates.

A higher prevalence of low birth weight was observed in the control group (6.7%) than in the intervention group (2.5%; p<0.001). Logistic regression identified significant associations between birth weight and intervention group (adjusted odds ratio [AOR]=0.26; 95%, 0.10-0.64); maternal height <154.5cm (AOR=3.33; 95% CI, 1.01-10.96); last antenatal care visits at 1st or 2nd trimesters (AOR=9.48; 95% CI, 3.72-24.15); pre-term delivery (AOR=3.93; 95% CI, 1.93-7.98); maternal mid-upper arm circumference <23cm (AOR=2.57; 95% CI, 1.15-5.78); and caesarean delivery (AOR=2.27; 95% CI, 1.04-4.94).

Nutrition counselling during pregnancy reduced low birth weight and preterm births, which was determined by women of short stature, early stoppage of antenatal visit etc.

2.2 Introduction

Globally over 20 million (15.5% of all births) and 15 million infants are born with low birth weight (LBW) and preterm delivery, respectively [1]. Low birth weight is defined as weight of less than 2500g within the first hours of life [2]. While preterm birth is any birth before 37 completed weeks of gestation [3]. Majority (95.6%) of LBWs and preterm births are reported from low- and middle-income countries with Sub-Saharan Africa and Asia reporting the largest numbers [4]. In addition, the UN statistics report a global steep and progressive decline in length-for-age status during the first three years [5]. These poor birth outcomes, are associated with significant morbidity and mortality worldwide. They contribute to a decline in child survival, causing 40% to 80% of neonatal deaths owing to related complications [6], stunted growth, disabilities, deficits in neurological development, and long-term health-related chronic diseases such as diabetes as well as cardiovascular diseases [7].

Risk factors of poor birth outcomes

Various risk factors have been reported to play an important role in influencing poor birth outcomes. One major risk to poor birth outcomes is poor maternal nutrition during pregnancy [6,8]. Unhealthy pre-gestational body mass index (BMI) (overweight and underweight), inadequate nutritional knowledge, anaemia and folic acid deficiency, teenage pregnancy, underlying chronic pre-gestational diseases, maternal height, irrational medication, inadequate regular physical exercise/activity, morbidity during pregnancy, poor antenatal care practices, poor lifestyle, low education levels, exposure to environmental toxins, psychosocial status such as presence of stress and socioeconomic level are some of the modifiable factors that cause poor birth outcomes. Conversely, the genetic constitution of the parents, sex of the foetus, multiple pregnancies, and ethnicity among others are unalterable even with interventions in place [9].

Notably, pregnant women from developing countries in particular those of poor socio-economic status (SES) have inadequate dietary practices, poor lifestyle, and a higher risk of both macro and micro nutrient deficiencies which increases their susceptibility to various prenatal morbidities associated with poor birth outcomes [10]. However, biologic, demographic, socioeconomic and environmental factors confound this association as explained in a conceptual framework by Abu-Saad et al [6]. The link between SES, environmental, and cultural factors on pregnant women's nutrition and birth outcomes is well studied and documented. For example, low socio-economic levels influence the purchasing power and quality of dietary intake during pregnancy [10]. Age at birth, parity, birth interval and taboos surrounding food intake during pregnancy are cultural factors impacting on maternal nutrition and their birth outcomes [11]. While intergenerational biological factors, maternal early life environment, nutrition status during childhood and adolescence may also affect foetus outcomes [12]. **Figure 2.1** illustrates a conceptual framework for determinants of poor birth outcomes adapted from a previous study [13].

Maternal nutrition counselling during pregnancy on improving birth outcomes

Inadequate knowledge on maternal nutrition is a significant determinant of poor birth outcome. A systematic review dated back in 1990s by Windsor and Boyd recommended the need for a high-quality prenatal nutrition education programs [14]. As a result, experimental and interventional studies have been put in place to improve mothers' prenatal health and child birth outcomes. For instance, Nutrition education and counselling (NEC), is a popular strategy conducted in health facilities to increase maternal knowledge towards improving their nutritional status during pregnancy [15]. It is based on the WHO recommendations on healthy eating and antenatal care for good pregnancy outcomes [16].

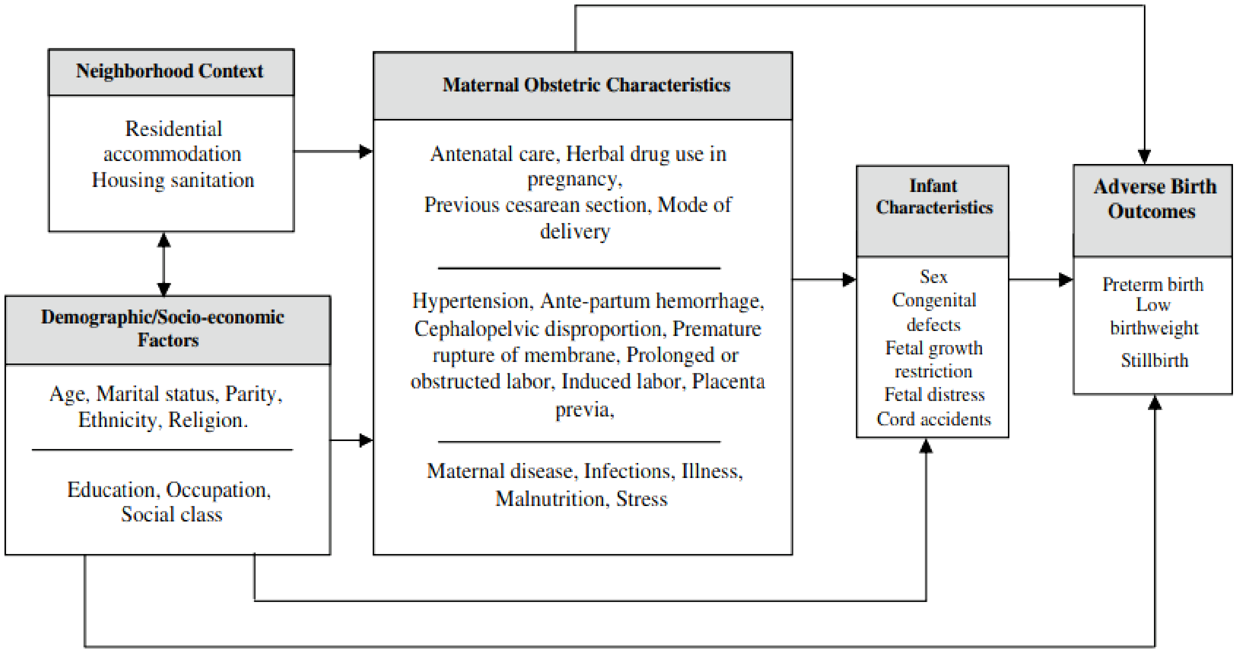

Figure 2. 1 Conceptual framework for poor birth outcomes [13].

Third trimester nutrition education coupled with food supplementation was demonstrated to have a positive impact on the nutrition knowledge of pregnant women and led to an improvement in gestational weight gain and neonatal birth weight among low and middle income populations [10,17,18]. However, Nair et al. did not report significant findings on birthweight in a similar randomized study of low-income women in India [19]. Previous studies have reported that tested nutritional interventions had no effect on improving birth outcomes, because of the variation in study designs and populations included likely to have biased the results toward the null hypothesis [6]. Therefore, it's not clear if offering nutrition education and counselling alone to pregnant women living in low income settings is sufficient in improving their nutrition status and birth outcomes. This is because evidence show that people rarely change their behaviour on the basis of telling alone [20] and that societal and environmental factors confound nutrition and behaviour change [21].

Consequently, more research still needs to be conducted to increase certainty on the effect of NEC offered to pregnant women living in urban informal settlements on their child's birth outcomes. Notably, studies on the effect of nutrition education and counselling on preterm delivery and stunting at birth are limited. However, two trials have reported that women who received nutritional education during pregnancy had a lower relative risk of having a preterm birth [10]. Moreover, to the best of our knowledge, no similar study of the effect of nutrition counselling on birth outcomes has been conducted in Kenya. Therefore, this study aimed at examining the effect of personalized home-based nutrition counselling of pregnant women on birth outcomes. This study also examined birth outcomes related risk factors and elucidated the combined effect of living in low socioeconomic households challenged with poverty, illiteracy, inadequate resources, and limited access to adequate nutrition.

2.2.1 Study objective

To examine the effect of personalized home based nutrition education and counselling on birth weight and other birth outcomes while reporting on the associated risk factors.

2.3 Methodology:

2.3.1 Study design and randomization

This study was embedded into a larger cluster randomized controlled trial, Maternal Infant and Young Child Nutrition (MIYCN), by the African Population and Health Research Center (APHRC) from 2012 to 2015. The primary outcome of the umbrella study was the effectiveness of personalized, home-based nutrition counselling of pregnant and postnatal women on the

prevalence of exclusive breastfeeding [22]. Hence, the effect of the intervention on birth weight and other birth outcomes was tested in this study. A computer-generated cluster-randomization system was used for pragmatic purposes and future follow-up of the cohort. The clusters were characterized as community units (villages). Since there were 14 clusters (villages) in the two study sites, seven of these villages were randomly assigned into a control group and the other seven into an intervention group by a data analyst who was not part of the study team to reduce chances of contamination of the control group, **Figure 2.2.** The clusters were stratified using the total number of women of reproductive age registered in the NUHDSS and slum of residence.

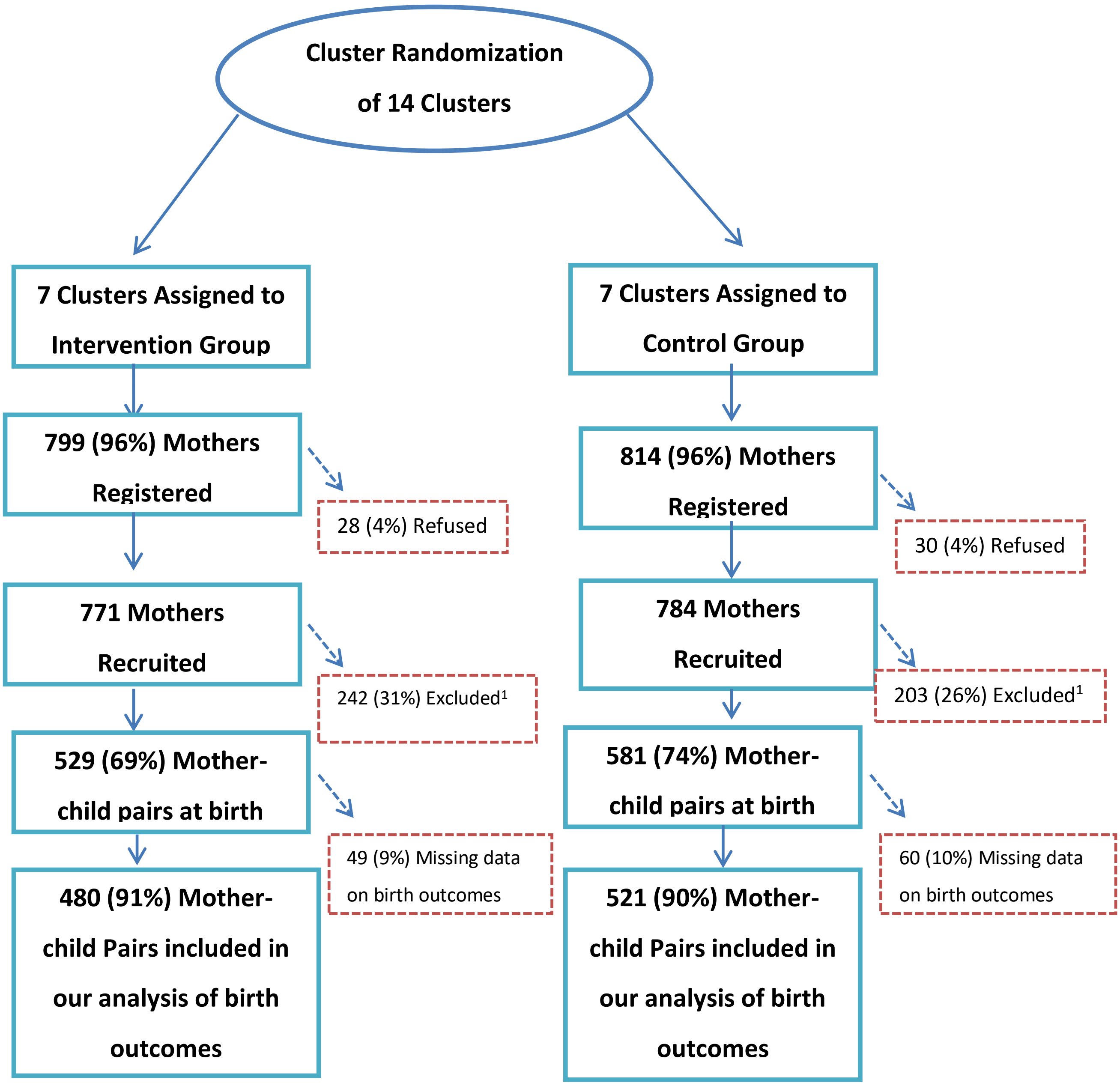

Figure 2. 2 Consort diagram for the randomized, controlled trial, MIYCN study, Nairobi slums, 2015

[1]Excluded or dropped due to loss to follow-up during pregnancy, migration or death of mother, giving birth before receiving the intervention and pregnancy loss (miscarriage/abortion or still birth).

2.3.2 Study area

Over 2.5 million city dwellers live in about 200 slum settlements of Nairobi, which represents 60% of Nairobi's urban population, **Figure 2.3**. The MIYCN project was nested within the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) run by the African Population and Health Research Center. The NUHDSS follows about 80,000 residents of two highly populated urban informal settlements (slums), Viwandani (52,583/km^2) and Korogocho (63,318/km^2), in Nairobi, Kenya, since 2003 [23]. These slums are located seven kilometres from each other and comprise 14 villages in total. Seven villages from both slums were assigned to the intervention groups while the other seven to the control group as illustrated in **Figure 2.2.**

Korogocho is the 4th largest slum in Nairobi, Kenya located 11 km from the capital city and with a total fertility rate of 3.7. Viwandani occupies 0.97 km^2 and its situated 7km from the city. The main disparity between the two slums is the difference in demographic profiles, **Figure 2.4.** Viwandani slums is mainly occupied by highly mobile migrant youths who are looking for jobs in the nearby industries while Korogocho residents have lived there for a long time. Both slums are characterized by food insecurity, poor sanitation and hygiene, poor housing, poor child nutrition indicators, and poor child feeding practices [24]. In addition, they have limited access to formal health care, inadequate education facilities, inadequate infrastructure, polluted environment (Dandora dumping site), violence/ insecurity and high unemployment rates.

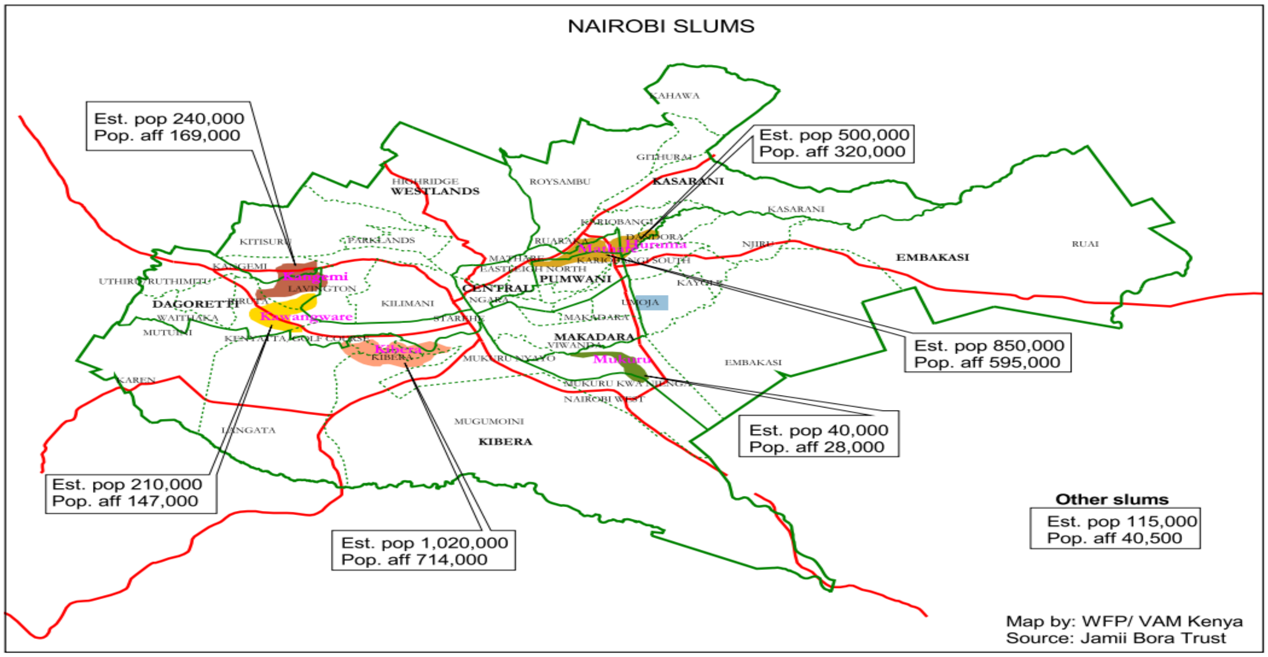

Figure 2. 3 Map of Nairobi showing slum areas and estimated population as of 2008.

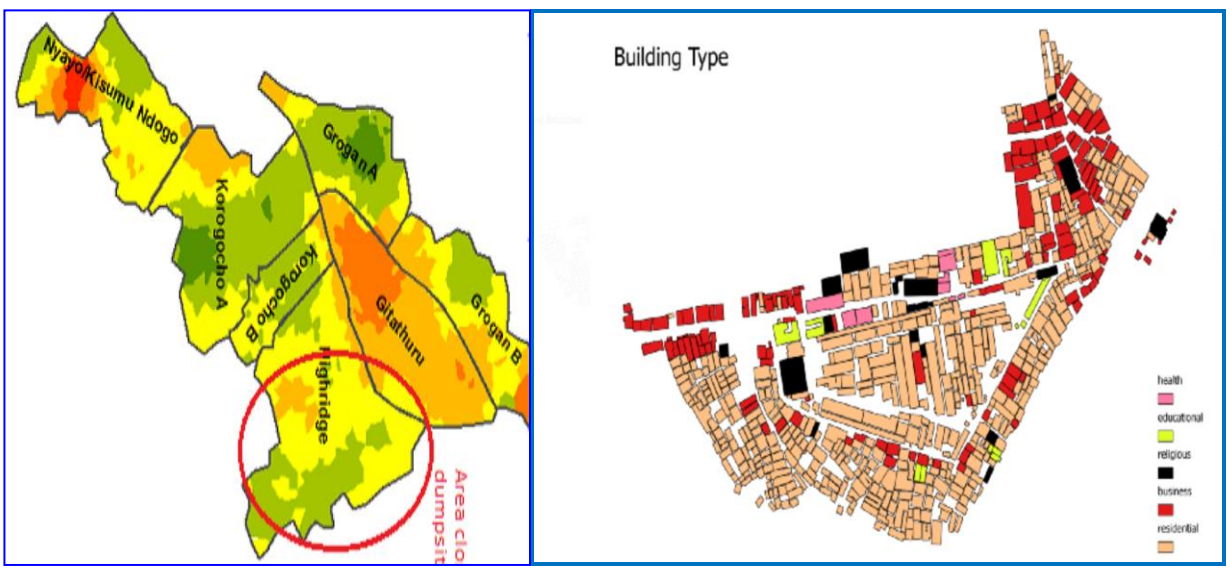

Figure 2. 4 Assorted digital maps of Korogocho (left) and Viwandani (right) Slums of Nairobi Kenya.

2.3.3 Study population

Recruitment of the study participants took place from September 2012 to February 2014. Pregnant women were prospectively included throughout the trimesters. To recruit most of the pregnant women, the NUHDSS register of quarterly collected data from households was used to identify pregnant women. Other pregnant women were identified by ANC providers and community health workers (CHWs). All women from the allocated clusters who became pregnant during the recruitment period between September 2012 to February 2014 were invited to participate in the study. Pregnancy tests was performed in the health facility to ascertain that she was pregnant and the date of her last menstrual period was determined through her recall.

Inclusion criteria:

It involved a pregnant woman, residing in the Korogocho or the Viwandani slum, aged between 12 to 49 years, registered within the NUHDSS, and voluntarily willing to participate by providing a written informed consent. Women aged below 15 years were included since a previous study by Ndungwa et al. reported that some of the adolescents in these slums were sexually active and became mothers before the age of 15 years [25]. All mother-child pairs with reported data on child’s birthweight, date of last menstruation, child’s date of birth, gestation age at birth and child’s length after birth were included in this analysis.

Exclusion criteria:

Those excluded were reproductive aged women who were to deliver before the intervention started, women with disabilities such as hearing and seeing hence could not benefit from the intervention. Women who lost the pregnancy (miscarriage/abortion or still birth), those lost to follow up through out-migration or death of mother or infant born with some birth defects were also dropped from the study.

2.3.4 Sample size calculation

Up to delivery, there were 529 mothers remaining in the intervention and 581 women remaining in the control group. In the current study, we analysed 480 and 521 mother-infant pairs in the intervention group and control group, respectively, with the information on birth weight and related variables. Sample size was justified based on a 0.11 kg-effect size, a mean birth weight difference in the intervention and control, as reported in a systematic review by Girard eta al [26] of similar studies from low- and middle-income countries. To achieve a power of 80%, at an alpha value of 0.05 and a beta value of 0.2 for a two-sided t-test, a variance of 0.76 was used. Thus, a calculated sample size of 806 (403 mother and infant pair from each study arm) was necessary to detect a significant difference.

2.3.5 Intervention and controls groups

The intervention group received nutritional counselling from trained CHWs now referred to as community health volunteers (CHVs). Thirty CHWs with basic standard training from the government and a minimum of primary school education were selected from the 14 villages also known as community units. Community Units (CUs) as defined by the national community health strategy were used as clusters. The CUs are geographically defined units with an approximate population of 5,000 people. Within each CU, a CHW provides primary health care services to people [27].

The CHW from the intervention villages were further trained using the community Infant and Young Child Feeding (IYCF) training package developed by UNICEF/WHO in 2006 and adopted by the government of Kenya. However, they were not aware of the study arm they were in. The trained CHWs passed down this information to the mothers primarily, but also to the fathers or other caregivers where possible in the intervention group. Counselling was initiated as soon as the mother was recruited, as early as possible during pregnancy, and then continued monthly till after one year following delivery. The intervention group CHW had a counselling work schedule and specific messages to be shared with the intervention group during each visit as highlighted in the counselling schedule, **supplementary material Table S1.**

A total of seven home-based, personalized nutrition-counselling sessions were offered during pregnancy to each pregnant woman in the intervention group. The first four sessions were conducted once in every fourth week till the 34th week of gestation, while the other three sessions were done weekly until the pregnant woman gave birth. Key messages were adopted from the training package and highlighted in brightly coloured IYCF counselling cards. These cards were used by the CHWs during counselling. The specific maternal nutrition education key messages included importance of adequate diet during pregnancy, attending an antenatal care clinic (ANC), and taking iron and folate supplements. Other maternal health-related key messages were on seeking early treatment for infections and how to prevent them, encouraging the use of good hygienic practices, avoiding alcohol, smoking, and non-prescription drugs, and good antenatal care [28].

The control group received usual ANC services, reading materials on MIYCN, and counselling visits on basic health care by the CHWs. The CHWs home visits are defined by the needs of the pregnant woman as a common practice specified under community health promotion strategies [27]. These CHWs did not receive the additional training on MIYCN as the CHWs in the intervention group did [22].

2.3.6 Data collection

Data collection was done at household level using semi-structured questionnaires. Fifteen trained and experienced field interviewers (independent from the CHWs) with a minimum of secondary school education collected data from the participants. Hand-held android tablet containing a semi structured pretested questionnaire installed in Open Data Kit (ODK) software was used. The questionnaires were subdivided into recruitment, baseline, anthropometry, pre-birth, household food security, and cohort follow-up questionnaires. The pregnant woman's anthropometrics and self-reported morbidity experience were taken every four months during the follow-up period between 2012 and 2015, depending on when she joined the cohort. Hence, the variables necessary for our study were taken twice, at baseline and pre-birth. Details on the contents of the questionnaire can be accessed through this website:

http://microdataportal.aphrc.org/index.php/catalog/87.

2.3.6.1 Measurements

New-born baby's weight was measured in the hospital during birth, therefore birth weight was recorded from clinic cards and mothers' recall for those who had misplaced the clinic booklet/card. New-borns recumbent length was measured using a length board, one month after birth. Measurements were taken to the nearest 0.1 cm, while the infant was lying in a supine position.

The pregnant woman's anthropometrics and self-reported morbidity experience were taken every four months during the follow-up period between 2012 and 2015, depending on when she joined the cohort. Hence, the variables necessary for our study were taken twice, at baseline and pre-birth. Calibrated electronic weighing scales were used to determine weight of the pregnant women in minimum clothing and without shoes. Weight was measured to the nearest 0.1kg. Two readings were taken, and the mean calculated. Mid-upper arm circumference (MUAC) tapes were used to take the circumference of the women's straightened arm. The MUAC thresholds of <23.0cm were applied to identify malnourished women who were at higher risk of delivering LBW babies [29]. The MUAC cut-off point for normal was 23 to 32cm and for overweight and obese, >33cm. The MUAC was preferred for analysis in this study since it reflects the nutritional status of the mother only, the measurements have a narrow range of cut-off values, it has been identified to have a strong association with LBW in previous studies, and it is rather insensitive to changes such as presence of oedema, which is common in pregnant women [29]. Additionally, the MUAC has been reported to be highly correlated with body mass index (BMI), and researchers suggest it can be used in place of BMI [30] .

A stadiometer was used to measure women's height in meters and the findings were recorded. The height quartiles were used as cut-offs for maternal stature, although the WHO classifies <145cm as short stature. The short stature cut-off (<154.5cm) in this study is comparable to a range of 146 to 157cm for women of short stature, which can be used to identify risk of LBW, as reported in a literature review by Ververs et al [29,31]. Blood pressure was measured using a blood pressure gauge. Cut-off points for elevated blood pressure, diastolic (>80 mmHg) blood pressure, and systolic (>120 mmHg) blood pressure were used. All measurements were taken by experienced interviewers who received training on anthropometric measurements based on guidelines recommended by the Centers for Disease Control and Prevention (CDC).

2.3.6.2 Data management and quality assurance

Weighing scales were calibrated daily to achieve data quality and accuracy of the measurements. Interviewers were adequately trained and frequently supervised during data collection. They were advised to collect data from one household at a time. Two subsequent readings were taken per participant and the average calculated to avoid parallax during reading of measurements. Moreover, completed questionnaires were cross-checked after measurements to ensure completeness of data, consistency of answers and the eligibility of the measurements obtained. Paperless data collection using ODK collect software was preferred to avoid missing data. Daily collected data was finalized and sent to the data managers through the ODK server system. Data managers examined all the filled questionnaires for completeness, noted data that seemed incorrect or missing values and requested the responsible interviewer to clarify or revisit the household to fill missing or verify incorrect data. The finalized cleaned data was merged combined and converted to the statistical such as SPSS for analysis.

2.3.7 Statistical analysis

The differences between the intervention and the control groups were tested in regard to the maternal baseline socioeconomic and demographic characteristics (maternal age, education levels, ethnicity, occupation, parity, nutritional status); follow-up ANC practices including the number of ANC visits; services offered such as personnel who assisted during delivery; place of delivery; morbidity during pregnancy (hypertension, anaemia, malaria, fever, gestational diabetes, nausea, and vomiting); and nutrient supplementation, among others. This analysis was conducted using the chi-square test, which was adjusted for village-based clustering and reported in proportions and p-values. Student's independent *t*-test was used to test differences between two means for the independent continuous variables (age, height, BMI, MUAC, and systolic and diastolic blood pressure). The mean birth weight and LBW proportions among the available maternal factors [9] were reported in the univariate analysis. The dependent variables were categorized into LBW (<2.5kg) and normal birth weight (>2.5kg), preterm delivery (<37 weeks), term delivery (>37 weeks) and stunting <-2SD Z score and the difference in proportions among the selected maternal factors reported.

In univariate analysis, logistic regression was used to test the associations between individual maternal risk factors with birth weight, preterm delivery and birth length one month after delivery and the effect size was reported using crude Odds Ratios (OR), beta coefficients, 95% confidence intervals (CI) and their p values. Multivariate logistic and linear regression was conducted to determine association between the birth outcomes and maternal factors which were significant at level 0.1 in univariate analysis to avoid the effect of confounding factors. Linear regression was also performed with birth weight as a continuous variable for some covariates. Interactions and multicollinearity were tested among variables in the final model. The strength of association between LBW and the covariates was reported using adjusted ORs and their 95% confidence intervals. Statistical significance was set at $p<0.05$ and analyses were carried out using the Statistical Package for the Social Sciences (SPSS) version 24, IBM New York.

2.3.8 Research ethics considerations

The initial MIYCN project (2012-2015) was approved by Kenya Medical Research Institute (KEMRI) and written informed consent from participants was sought. Ethics approval for this study was sought from the ethical committee, Faculty of Medicine, University of Tsukuba. Confidentiality and privacy was maintained.

2.4 Results

2.4.1 Baseline information of the women by study group, at enrolment

The control group had a slightly higher number of participants (n=521) than did the intervention group (n=480). The baseline nutritional status and the socioeconomic and demographic characteristics were comparable between the study groups except for occupation and parity (Table 2.1). All the women were aged between 14 and 45 years. Most of the women in both study groups had attended up to elementary school, were unemployed, and were having either their first or second child. Maternal mean (SD) height and BMI was similar in both the intervention and the control groups, 158.7 (8.8) cm and 25.2 (4.6) kg/m^2, respectively.

Almost a quarter of the women (22.5%; n=400) were taking nutritional supplements at baseline, which was slightly more in the intervention (23.9%) than in the control group (21.3%) but did not meet the level of significance. However, even though at baseline a level of significance was not achieved, during follow-up, more women (30.5%; n=400) reported using nutritional supplements with an increased proportion in the control group (31.5%) as compared with the intervention group (29.3%). Very few women (0.6%) consumed alcohol during pregnancy. On the other hand, 30.8% had pica (eating stones or soil) during the baseline period (Table 2.1). Conversely, during the follow-up, the proportion of those with pica decreased significantly ($p<0.001$) in the intervention group from 30.5% at baseline to 19.2% as compared with the control group, in which pica increased slightly from 31.1% to 32.2%.

2.4.2 Follow-up antenatal check, and infant deliveries

Most of the pregnant women (90.5%) attended ANCs, with a mean (SD) number of visits of 3.62 (1.6) (median 4). The intervention group reported an almost comparable mean (SD) number of ANC visits 3.67 (1.6) as the control group’s mean (SD) 3.54 (1.5). Both study groups received similar types of antenatal care services such as an HIV test, blood pressure measurements, ultrasound scans, iron supplementation, antimalarial tablets, deworming tablets, mosquito nets, tetanus vaccination during the first antenatal care check, and weight monitoring at every visit. The proportions of the services received did not differ significantly between the intervention group and the control group. Moreover, significantly more women in the intervention group attended ANC during the third trimester.

2.4.3 Maternal nutrition status and pregnancy-related morbidity and mortality

During baseline when majority of the women were in their first or second trimester, the mean (SD) weight was 63.31 (10.37) with similar average weight observed in both study groups and BMI (SD) of 25.78 (2.8) in the intervention group and 25.88 (3.1) in the control group, while during the third trimester, pregnant women's mean weight (SD) was 65.68 (10.6) and BMI of 25.68 (2.8) in the intervention group and 26.56±4.5 in the control group. The prevalence of underweight women was significantly reduced in the intervention group as compared with that in the control group by examination of their mid-upper arm circumferences (MUAC <23cm). In addition, during follow-up, there were more overweight and obese women in the control group, MUAC mean (SD) 26.56 (4.5) cm, than in the intervention group, MUAC mean (SD) 25.68 (2.8) cm. The mean (SD) for MUAC was similar to the mean (SD) BMI in both study groups.

At enrolment, the systolic blood pressure reading was normal (91–120 mmHg) in 83.2% of the pregnant women, less than 90 mmHg in 11.1%, and above 120 mmHg in 5.6%. The diastolic blood pressure reading was normal (61–79.9 mmHg) in 72.7% of the pregnant women, 60 mmHg or below in 19.1%, and above 80 mmHg in 8.1%. The observed measurements for the systolic and diastolic blood pressures were almost similar at baseline and late pregnancy, and no statistical differences were observed between the study groups.

At baseline, the prevalence of women in the control group who reported having experienced severe nausea and vomiting (48.5%), malaria (17.7%), and fever (27.7%) was significantly higher (p=0.001) than that in the intervention group (39.8%, 11.9%, and 14.4%, respectively).

Comparisons of the baseline and follow-up data showed slight but not significant reductions in malaria, anaemia, bleeding, spotting, severe nausea, and vomiting in the intervention group, but no changes in the control group. During pregnancy, elevated blood pressure was experienced by only 2.5% of the women; bleeding or spotting by 3.8%; and anaemia, by 6.5%. The difference between the intervention and the control group was not statistically significant. Other pregnancy-related medical conditions were swollen legs (14.2%), depression (2.4%), fainting (2.8%), varicose veins (1.3%), and gestational diabetes (0.8%) (Table 2.3). When these conditions were tested for association with birth weight, none of the morbidities of the mother had a significant association. Prenatal and infant mortality was similar for both study as illustrated in (Table 2.6.)

2.4.4 Child birth outcomes

Most of the women (98.6%) from both study groups delivered in the health facility, with 95.4% of these deliveries being assisted by skilled personnel (doctor, nurse, midwife or clinical officer). The majority (92.4%) of the babies were weighed at birth. Similar proportions (18.2%) of women delivered via caesarean section (CS) in both study groups. However, the mean (SD) gestation age at birth for CS deliveries was 38.58 (3.4) weeks and 38.54 (3.6) weeks in the intervention group and the control group, respectively; the difference was not statistically significant (Table 2.2). **Figure 2.5** illustrates the prevalence of child poor outcomes per study arm.

The mean (SD) gestational age at birth was 38.6 (3.8) weeks. Women in the control group and the intervention group had similar mean (SD) gestational age at birth, 38.54 (3.8) weeks and

38.58 (3.7) weeks, respectively. Significantly more (27.6%) preterm babies were born in the control than in the intervention group (23.2%). In addition, significantly (p=0.018) more female infants were born slightly earlier, mean (SD) 38.14 (3.5) weeks, than male infants, 38.97 (3.6) weeks.

The mean birth weight (SD) was 3.24 (0.52) kg (range, 1–5.8 kg). A significantly higher proportion of low birth weight (6.7%) babies were born in the control than in the intervention group (2.5%). Male infants weighed slightly more than female infants. Slightly more female infants than male infants were also born with LBW.

Child mean (SD) length one month after birth was 53.4 (4.3) cm in the control group 53.8 (4.1) cm in the intervention group. Male children in the intervention group were born slightly taller by 0.57cm than the control group. A total of 124 (27.2 %) infants were stunted in the control group as compared to 93 (23.9 %) in the intervention group, **Figure 2.5.**

2.4.5 Regression analysis for determinants of child poor birth outcomes

In univariate analysis, women in the intervention group had a lower risk of LBW and preterm delivery. Further, women with short stature, first time delivery, fewer antenatal care visits, MUAC of less than 23 cm, doctor-assisted delivery, teenage mothers, preterm births (<37 weeks), events of fever during pregnancy, and discontinued ANC visits in the second trimester had higher odds of poor birth outcomes.

Variables for which a significance of $p<0.10$ was obtained in the univariate analysis were tested using multiple logistic regression analysis. None of the baseline variables other than parity and mother's height had a significant association with poor birth outcomes, (Table 2.4.) The intervention group was protective for LBW, preterm delivery but no significance for stunting. While shorter women (<154.5cm) had higher odds of low birthweight and stunting at birth. In addition, discontinued ANC visits at first and second trimester, the higher the odds of low birth weight and preterm delivery. Other factors significantly associated with poor birth outcomes were: younger mothers, delivery by C section. Moreover, preterm delivery and low birth weight increased the odds of stunting at birth. While MUAC, mode of delivery and gestational age at birth and time of last visit to ANC reported a significant association with LBW in multiple linear regression, (Table 2.5).

2.5 Discussion

The findings of this study demonstrated an association between birth weight and pregnant women's participation in a nutrition education program. This study had similar findings to a previous study conducted in Burkina Faso among low-income women [18]. Akter et al and Jahan et al [17,32] reported in separate studies that women who received third trimester nutrition counselling on pregnancy weight gain added 1.73 kg and 3.22 kg, respectively, more than women in the control group. In addition, babies born to women in these two studies weighed 0.44 kg and 20% more, respectively. However, their intervention had a food supplement (khichuri), unlike our study's intervention.

Overall, Kenya showed a slight increase in the prevalence of LBW from 6% to 8%, as reported in 2009 and 2014, respectively, by the Kenya Demographic and Health Survey (KDHS) [33,34]. The prevalence of LBW among infants in the control group was similar to recent findings reported by Mutual et al [35] for Nairobi's Viwandani and Korogocho slums.

Therefore, home-based nutrition counselling may have informed pregnant women in the intervention group on recommended antenatal care, which translated to adoption of good nutrition and adequate ANC practices. This is evidenced by positive changes in some of the maternal variables, such as more ANC visits and better nutrition status among women in the intervention group than among those in the control group. In addition, the number of their ANC visits was slightly higher than those of the control group, and slightly more women attended up to the third trimester. Moreover, the prevalence of undernutrition and over nutrition in the intervention group was reduced, as revealed by the comparison of the baseline and follow-up (pre-birth) MUAC measurements. However, some studies have argued that MUAC does not change during pregnancy. Conversely, Lopez et al in their cohort study conducted in Argentina reported a MUAC mean increase of 1.7 cm among 1000 pregnant women between the 16th and 38th gestational week [36]. Moreover, Lopez et al reported means (SD) of MUAC similar to the BMI at baseline and follow-up. Cooley et al and Sultana et al [30,37] reported significant correlations ($r = 0.836$) between the MUAC and BMI and suggested that BMI can be directly estimated from the following equation: $BMI = MUAC \pm 2$. Previous studies also reported a significant association between MUAC and birth weight, with women who gave birth to LBW infants reporting low MUAC values [38]. Although some studies have reported that overweight and obese women are at risk of delivery of macrosomia infants, [39] a slightly higher prevalence of LBW infants was also shown in women with higher MUAC measurements in this study. In addition, the control group had more underweight and overweight/obese women than did the intervention group. This could be the cause of LBW due to preterm delivery since Aly et al [40] reported obese women to be more likely to deliver prematurely owing to increased risk of gestational diabetes, preeclampsia, and anaemia.

Women in the intervention group had a reduction in consumption of soil and mineral stones, which is a form of pica caused by micronutrient deficiency, mostly iron deficiency [41]. Soil consumption pica may increase the transmission of soil helminths such as hookworms, which may lead to anaemia and later LBW [42], however, in our study, haemoglobin was not measured hence not enough evidence to conclude. The women in the control group had a higher intake of nutrient supplements during the follow-up, which could be a result of supplementation recommendation stemming from nutrient deficiency [43].

In addition, maternal height and antenatal characteristics such as parity, time at which the pregnant woman stopped seeking ANC, and mode of delivery, which are significantly associated with LBW, preterm delivery and stunting, were consistent with those found in similar studies of predictors of LBW [39,40,44,45]. For instance, some studies have reported that few ANC visits is associated with LBW because of inadequate ANC services such as nutrition counselling, low micronutrient intake, and reduced chances of identifying risks such as pregnancy-related morbidity and other risks that might lead to IUGR and preterm births [46]. Additionally, women in the control group reported slightly higher proportions of overweight and obesity, however, they had significantly more poor birth outcomes. This paradox is as a result of the double burden of malnutrition. Urban slums have a challenge of accessing adequate, safe and healthy foods, majority shift to high energy dense diets which are high in saturated fat, sugar, and refined foods because they tend to be cheaper than the healthy plant-based diets. They also have inadequate access to health care services because of poverty and less physical activity owing to limited space to exercise. Moreover, inadequate nutrition knowledge contributes to their lack of awareness on overweight and obesity. Therefore, this double burden of malnutrition is a challenge to urban informal dwellers [47]. A study using data from the latest demographic survey in Kenya reported women's overweight prevalence of 20.5%, and obesity of 9.1% [48] while those from the slums had higher proportions of overweight and obesity (43.4% among women and 17.3% among men) as reported in a study conducted in these two study sites [49].

The proportion of deliveries by caesarean was almost similar to the proportion of Nairobi (20.7%) county as reported in the 2014 KDHS [33]. Deliveries by caesarean section may have led to LBW since some births take place before term owing to miscalculated gestational age or early planned deliveries. In addition, medical complications associated with LBW such as eclampsia may increase the demand for caesarean delivery; hence, the baby is born before reaching term. This study findings are consistent with those in a study by Coutinho et al. [50], who reported that infants born via caesarean were 1.4 times more likely to have a LBW than were those born via vaginal delivery.

The study participants exhibited low socioeconomic and education levels, which is a characteristic of slum dwellers [51]. No significant associations were observed between LBW and most of the socioeconomic and demographic characteristics such as maternal education levels and marital and employment status. In contrast, previous studies from other developing countries, but not restricted to slum populations, have reported significant associations [45]. The discrepancy may have resulted from the fact that most women living in slums do not have significant differences in their socioeconomic and demographic statuses. Similar findings were reported by Mogire et al. [52] in a study conducted in a Pumwani maternity hospital in Nairobi, which is attended mostly by women from low socioeconomic households.

2.5.1 Study strengths and limitations

This was a large and well-organized randomized controlled study, with good data management, increasing the reliability of the data. In addition, to the best of our knowledge, it may be the first study reporting the effect of nutrition education offered in Kenyan slums on child's birth weight.

However, the study has some limitations. The intervention focused on increasing awareness for pregnant women to exclusively breastfeed for up to six months. Hence, not so much emphasis was laid on information needed for promoting birth weight. In addition, pregnancy-related medical conditions were self-reported, which could have led to reporting bias while multiple pregnancies were not specified hence not controlled for during analysis. Moreover, mother's pre-pregnancy weight and BMI and weight during delivery was not reported, anthropometric measurements were only recorded twice, during baseline and third trimester, while some women were in their second and third trimester during recruitment, therefore the gestational weight gain was not calculated to report its influence on birth outcomes. Lastly, the study population is an urban informal settlement, which to some extent limits the generalizability of the results to the whole country; however, generalization to similarly impoverished low-income households is possible. Moreover, some of the study findings on antenatal care maternal baseline characteristics closely correspond to those reported in the 2014 KDHS for low-income settings.

2.6 Conclusion

Home-based nutrition counselling during pregnancy reduced the prevalence of low birth-weight, preterm deliveries and stunting at 1-month post-delivery. This is evidenced by improvement in the pregnant women's nutritional status and more use of ANC services in the intervention group as compared with the control group. Therefore, this study has provided fundamental evidence that offering monthly home-based personalized counselling to pregnant women by CHWs can essentially improve maternal nutrition and child birth outcomes. A number of risk factors for poor birth outcomes were identified, therefore, the government and other health care providers should focus on modifiable risk factors such as improvement of pregnant women's nutritional status through offering nutrition counselling and promoting maximum use of ANC services especially in slum areas.

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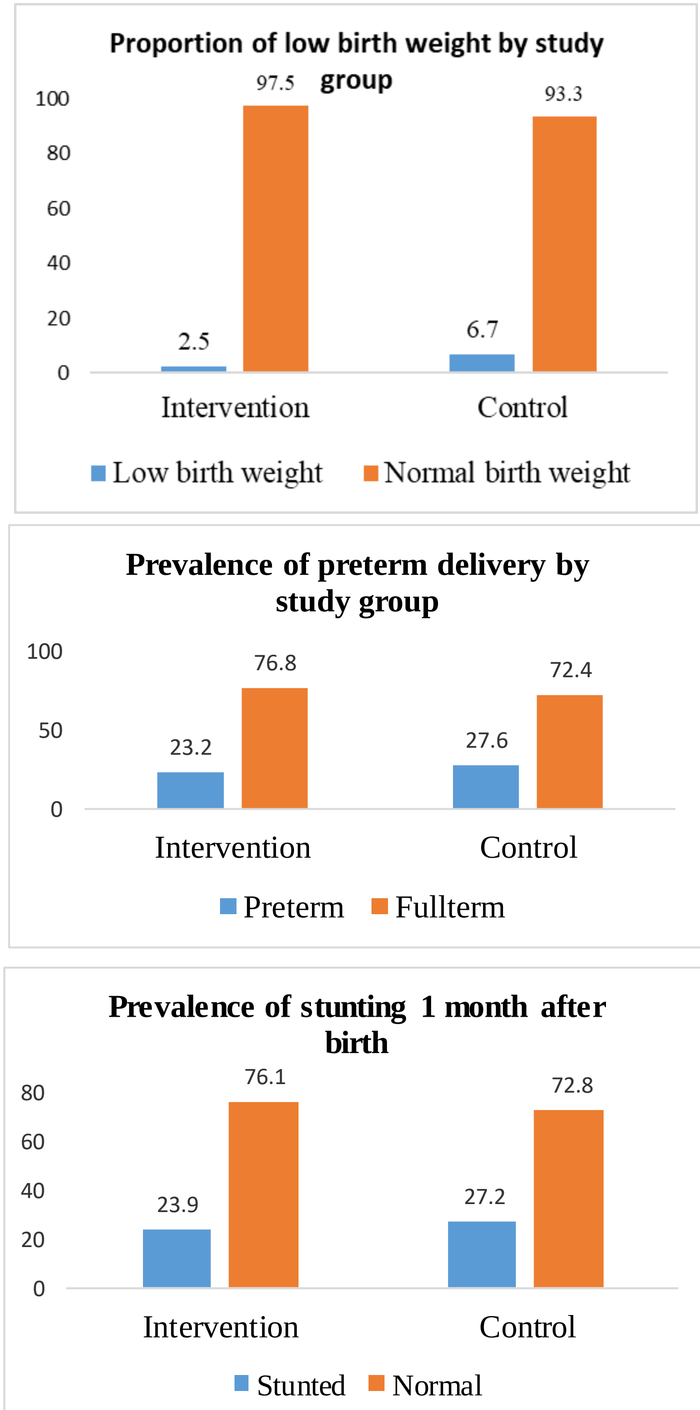

Figure 2. 5 Prevalence of low birth weight, preterm delivery and stunting at birth

Table 2. 1 Baseline characteristics of the women by study group (at enrolment)

Variable	Control n=521	Intervention n=480	p-values
Age group	**n(%)**	**n(%)**	
14-19	88 (16.9)	80 (16.6)	
20-24	212 (40.7)	209 (43.5)	0.112
25-29	127 (24.4)	127 (26.4)	
30-45	94 (18.0)	64 (13.5)	
Highest level of education			
Less than primary	84 (16.1)	67 (14.1)	
Completed primary	303 (58.3)	272 (56.6)	0.276
Secondary school	114 (21.8)	119 (24.8)	
College/university	20 (3.8)	22 (4.5)	
Occupation			
Unemployed	481 (92.3)	406 (84.7)	
Self-employed	22 (4.2)	38 (7.9)	0.023
Casual labour	13 (2.5)	22 (4.5)	
Salaried	5 (1.0)	14 (2.9)	
Marital status			
Married/living together	433 (83.2)	383 (79.8)	
Single	60 (11.6)	65 (13.5)	
Separated/divorced	18 (3.5)	17 (3.6)	0.235
Widowed	2 (0.5)	3 (0.6)	
Missing	6 (1.2)	12 (2.5)	
Ethnicity			
Kikuyu	136 (26.0)	137 (28.6)	
Luhya	108 (20.7)	84 (17.5)	0.180
Luo	75 (14.4)	79 (16.5)	
Kamba	105 (20.2)	93 (19.4)	
Others	97 (18.7)	87 (18.0)	
Maternal height, cm			
<154.5cm (25th percentile)	136 (26.2)	119 (24.8)	
154.5-163.0cm (50th percentile)	278 (53.3)	252 (52.4)	0.845
>163 cm (75th percentile)	107 (20.6)	109 (22.8)	

Mid-upper arm circumference, cm			
Lower (<23 cm)	75 (15.6)	83 (15.9)	
Normal (23-32 cm)	415 (79.7)	394 (82.1)	0.108
Overweight and obese (>33 cm)	23 (4.4)	11 (2.3)	
Time in weeks of the 1st ANC visit			
First trimester (<13 weeks)	39 (7.5)	47 (9.8)	
Second trimester (13-28 weeks)	424 (81.4)	387 (80.6)	0.331
Third trimester (>28 weeks)	58 (11.1)	46 (9.6)	
History of stillbirth			
Yes	70 (13.4)	61 (12.8)	0.215
No	451 (86.6)	419 (87.2)	
Parity			
0	183 (35.2)	194 (40.5)	
1	162 (31.2)	148 (30.8)	0.025
2 and more	176 (33.6)	138 (28.7)	
Infant's sex			
Male	270 (51.8)	241 (50.2)	0.151
Female	251 (48.2)	239 (49.8)	
Taking nutrient supplements			
Yes	111 (21.3)	115 (23.9)	0.135
No	410 (78.7)	365 (76.1)	
Consumed soil/mineral stones (pica)			
Yes	162 (31.1)	146 (30.5)	0.421
No	359 (68.9)	334 (69.5)	
Previous reported under 5 child deaths	**n=61**	**n=54**	
<2 children	53 (86.5)	47 (87.2)	
2-3 children	8 (12.4)	6 (11.5)	
>4 children	1 (1.1)	1 (1.3)	

Data are presented as a number and percentage with p-values based on the chi-square test, which accounts for clustering at the village level.

Table 2. 2 Health information collected during follow-up visit by the study participants (at the last home visit before delivery)

Variable	Control n=521	Intervention n=480	p-value
Average number of ANC visits	**n (%)**	**n (%)**	
3 or less times	254 (48.8)	230 48.0)	
4-5 times	232 (44.4)	191 (39.8)	0.003
6 or more	35 (6.8)	59 (12.2)	
Time of last ANC visit [a], weeks			
1st and 2nd trimester (<28 weeks)	27 (5.1)	13 (3.0)	
3rd trimester (≥ 28 weeks)	494 (94.9)	466 (97.0)	0.030
MUAC, cm			
At risk of LBW (<23 cm)	64 (12.3)	50 (10.4)	
Normal (23-32 cm)	414 (79.5)	422 (88.0)	<0.001
Overweight and obese (≥ 33 cm)	43 (8.2)	8 (1.6)	
Delivery personnel			
Doctor/clinical officer	277 (53.1)	169 (35.3)	
Nurse/midwife	228 (43.7)	281 (58.6)	<0.001
Others [b]	16 (3.2)	20 (6.1)	
Mode of delivery			
Spontaneous vertex delivery	425 (81.6)	388 (80.8)	0.407
Caesarean	96 (18.4)	92 (19.2)	
Place of delivery			
Health facility	513 (98.5)	473 (98.6)	0.132
Home	8 (1.5)	7 (1.4)	
Birth weight distribution			
LBW (<2.5 kg)	35 (6.7)	12 (2.5)	
Normal (2.5-3.9 kg)	444 (85.2)	430 (89.6)	<0.001
Macrosomia (≥4 kg)	42 (8.1)	38 (7.9)	
Mean gestation age at birth, weeks			
Preterm births (<37 weeks)	144 (27.6)	411 (23.2)	0.003
Term and post term births (≥ 37 weeks)	377 (72.4)	369 (76.8)	

[b] relative, neighbour, friend, self, traditional birth attendant; MUAC: mid-upper arm circumference

Table 2. 3 Maternal self-reported morbidity during pregnancy

	Enrolment (Baseline information)			After Intervention (Pre-Birth Data)[c]		
Morbidity Experience (n, %)	Control n=521	Intervention n=480	p-value	Control n=521	Intervention n=480	p-value
High blood pressure						
Yes	14 (2.6)	12 (2.5)	0.548	9 (1.8)	14 (3.0)	0.943
No	507 (97.4)	468 (97.5)		512 (98.2)	466 (97.0)	
Gestational diabetes						
Yes	3 (0.6)	4 (0.8)	0.474	3 (0.6)	4 (0.8)	0.510
No	518 (99.4)	476 (99.2)		518 (99.4)	476 (99.2)	
Malaria						
Yes	92 (17.7)	57 (11.9)	0.001	41 (7.9)	47 (9.7)	0.001
No	429 (82.3)	423 (88.1)		480 (92.1)	433 (90.3)	
Fever						
Yes	144 (27.7)	69 (14.4)	0.001	153 (29.4)	69 (14.3)	0.000
No	376 (73.0)	411(85.6)		368 (70.6)	411 (85.7)	
Anaemia						
Yes	45 (8.6)	37 (7.7)	0.300	39 (7.5)	26 (5.4)	0.422
No	476 (91.4)	443 (92.3)		482 (92.5)	454 (94.6)	
Severe nausea and vomiting (morning sickness)						
Yes	253 (48.5)	191 (39.8)	0.001	212 (40.6)	179 (37.2)	0.002
No	268 (51.5)	289 (60.2)		309 (59.4)	301 (62.8)	

[c] Majority (73.7%) were in the third trimester during data collection and there was no statistical difference among the group.

Table 2. 4 Logistic regression analysis for predictors of poor birth outcomes

¶Predictor Variables	Category	†Low birthweight Adjusted OR; 95%CI	†Preterm births Adjusted OR; 95%CI	†Stunting at birth AdjustedOR;95%CI
Study group	Intervention	0.26 (0.10-0.64) **	0.84 (0.69-0.93) **	0.79 (0.55-1.03)
	Control	ref	ref	ref
Mother's height	<154.5	3.33 (1.01-10.96) *	1.39 (1.09-1.78)	1.73 (1.11-2.69) *
	154.5-163	1.92 (0.62-5.98)	1.31 (1.07-1.61)	1.68 (1.07-2.62) *
	>163	ref	ref	ref
Infant sex	Male	0.81 (0.43-1.52)	1.01 (0.86-1.18)	1.40 (1.04-1.91) *
	Female	ref	ref	ref
Time of the last antenatal care visits	1st and 2nd trimester	9.48 (3.72-24.15) **	3.75 (1.89-7.43) *	0.43(0.95-1.94)
	3rd trimester	ref	ref	ref
Mother's late pregnancy mid upper arm circumference	<23 cm	2.57 (1.15-5.78) *	2.40 (1.16-4.95) **	1.76 (1.75-4.09) *
	23-32 cm	1.71 (0.37-7.55)	1.43 (0.97-2.10)	0.87 (0.38-1.98)
	33>	ref	ref	ref
Parity	0-1 child	3.55 (1.37-9.15) **	0.49 (0.32-0.74) *	0.87 (0.64-1.19)
	2 and more	ref	ref	ref
Mother's age (years)	14-24	2.26 (1.02-4.99) *	0.87 (0.83-1.14)	1.15 (0.85-1.54)
	25-45	ref	ref	ref
Mode of delivery	Caesarean	2.27 (1.04-4.94) *	1.24 (0.83-1.85)	1.06 (0.72-1.56)
	Normal (SVD)	ref	ref	ref
Gestational age at birth	Preterm	3.93 (1.93-7.98) **	N/A	1.80 (1.28-2.55) *
	Term	ref		ref
Birth Weight	<2.5kg	N/A	0.190*	4.86 (2.49-9.50) **
	2.5-3.9kg		Correlation coff.	0.70 (0.37-1.34)
	>4.0kg			ref

AOR-adjusted odds ratio, adjusted for doctor assisted delivery, infant sex, and fever during pregnancy. P<0.05 * P<0.001**. ¶Covariates for each outcome/dependent variable †Dependent variables for final logistic regression each model was performed separately.

Table 2. 5 Multiple linear regression analysis for possible determinants of low birth weight

Variable categories	Standardized Beta Coefficients [a]	95%CI	p-value
Study group	0.07	(0.01-0.15)	0.036
Mode of delivery	0.11	(0.05-0.22)	0.002
Mother's pregnancy MUAC	0.12	(0.01-0.03)	<0.001
Child sex	-0.04	(-0.11-0.02)	0.198
Gestation age at birth	0.18	(0.02-0.03)	<0.001
Time of last visit to ANC, weeks	0.08	(0.00-0.01)	0.020

[a] Was standardized with adjustment of mother's age, fever, taking nutrient supplements and personnel who assisted with delivery)

MUAC: mid upper arm circumference, ANC: antenatal care

Table 2. 6 Baseline and follow-up infant and young child mortality

Variable	**Category**	**Control n=757**	**Intervention n=690**	p-value
Ever given birth to a child who later died	Yes	89 (11.8)	81 (11.7)	
	No	668 (88.2)	609 (88.3)	0.426
Number of children who ever died (control n=89, intervention n=81)	1	77 (86.6)	71 (87.7)	
	2	9 (10.0)	7 (8.6)	
	3 or more	3 (3.4)	3 (3.7)	
Ever had a pregnancy that did not result to live birth	Yes	102 (13.6)	82 (12.1)	
	No	655 (86.4)	598 (87.9)	0.215
Number of pregnancies that did not result to live birth (control n=102, intervention n=82)	1	80 (78.4)	71 (86.6)	
	2	17 (16.7)	8 (9.8)	0.210
	3 or more	5 (4.9)	3 (3.6)	

Follow-up neonatal, infant and young child mortality

Variable	Category	Control Total n=	Control infants who died n (%)	Intervention Total n	Intervention infants who died n (%)	
Index/study child died	Post-birth 1 (1 month)	538	15 (2.7)	476	13 (2.7)	0.33
	Post-birth 2 (4 month)	432	3 (0.7)	414	2 (0.5)	0.547
	Post-birth 3 (7th month)	478	1 (0.2)	431	5 (1.3)	0.069
	Post-birth 3 (9th month)	295	0 (0.0)	261	1 (0.3)	0.134
	Post-birth 3 (11th month)	150	0 (0.0)	156	1 (0.6)	0.214
	Post-birth 4 (13th month)	241	2 (0.8)	215	0 (0.0)	0.372
Was the child ill before she died	Yes		8 (38.0)		10 (43.5)	
	No		9 (42.9)		8 (39.1)	0.767
	Still birth		4 (19.1)		4(17.4)	
Causes of death (n)	Pneumonia		2		2	
	Diarrhea/Vomiting		1		2	
	Chest problems		3		2	
	Malaria/fever		0		3	0.628
	Others*		4		7	
	Don’t know		11		6	

***others: was self-reported as specified by the mother:** “**still birth** 1 mother said “because the baby drunk too much blood in the stomach before due date,” “2 mothers reported that their babies drunk amniotic fluid and got tired during delivery; 1 said umbilical cord was tied on the neck, 2 babies did not cry after birth and were incubated, **after delivery:** 1 had swollen liver, 1 had meningitis, 1 stomach pain, 2 difficulty in breathing.

CHAPTER THREE: Effect of Maternal Nutritional Education and Counselling on Children’s Stunting Prevalence

3.1 Abstract

Few studies conducted in urban informal settlements report inconclusive results on the effect of maternal nutrition education and counselling on child nutrition status. The aim of this study was to determine whether the prevalence of stunting differed between an intervention group and a control group and to identify factors associated with the children's linear growth.

This was a follow-up study of mother-child pairs who participated in a 2012–2015 cluster randomized controlled trial. The study was conducted in two slums in Nairobi. The intervention group received monthly nutrition education and counselling during pregnancy and infancy period. A birth cohort of 1004 was followed up every three months after delivery to the 13^{th} month. However, as a result of dropouts, a total of 438 mother-child pairs participated during the 55-month follow-up. The loss to follow-up baseline characteristics did not differ from those included for analysis. Linear mixed-effects models were performed to model the children's linear growth and identify the determinants of child linear growth.

Length-for-age z-scores decreased from birth to the 13th month, mean –1·42 (SD 2·04), with the control group (33·5 %) reporting a significantly higher prevalence of stunting than the intervention group (28·6 %). Conversely, the scores increased in the 55th month, mean –0·89 (SD 1·04), with significantly more males (16·5 %) stunted in the control group than in the intervention group (8·3 %). Maternal stature of <154 cm and early weaning were negatively associated with children's linear growth. Children born in Korogocho, women with BMI of <18.5kg/m^2, shorter mothers <154.5cm, children in the control group, male child, those who often returned food from the mouth through vomiting/regurgitating, early weaned were less

likely to grow taller as compared to their counterparts. While normal birth weight, longer breastfeeding, slow and moderate pace of child feeding and mother washing hands before preparing child food was positively associated with child linear growth

Home-based maternal nutrition education and counselling reduced stunting among under-five years, however, the long-term benefits of this intervention on children's health need to be elucidated.

3.2 Introduction

Over 3.1 million annual deaths among under five-year-old children is attributable to undernutrition in the first 1000 days with majority of deaths reported from Sub-Saharan Africa [1]. Malnutrition is a widely recognized public health problem with stunting documented as a key indicator of overall children's well-being and a reflection of social inequalities [2]. According to WHO, stunting is the predominant form of malnutrition with 161 million children affected worldwide [3] and most of these cases are from low and middle income countries (LMICs) [4]. Even though the prevalence of stunting has decreased in the past two decades, Sub-Saharan Africa (SSA) and south Asia continue recording higher rates than other regions [1]. Most of the countries with high prevalence of malnutrition have not made substantial strides in reducing or eliminating it [5]. Effects of malnutrition are highly correlated with short- and long-term adverse health effects on the affected children. For example, it hinders optimal growth and development, and impairs the immunological capacity of the affected children, increasing their susceptibility to illnesses and all forms of infectious diseases. Furthermore, malnutrition, both over and undernutrition have long-lasting physiologic effects, including an increased susceptibility to fat accumulation mostly in the central region of the body, lower resting and postprandial energy expenditure, lower fat oxidation, hypertension, insulin resistance in adulthood, dyslipidaemia and a reduced capacity for manual work, among other impairments [6].

Multiple risk factors have been identified as determining factors of poor child nutrition status. Fenske et al. [7] and Goudet et al. [8] report a comprehensive analysis of these risk factors by presenting conceptual frameworks showing the determinants of stunting and child undernutrition, respectively. Factors such as low birth weight as a result of premature birth or intrauterine growth restriction (IUGR) [9], poor hygienic practices, child morbidity [8], inadequate infant and young-child feeding practices through the first two years of life, among other predicting factors [7] have been associated with malnutrition. Inadequate infant and young-child feeding practices through the first 2 years of life is one of the major determinant of the high burden of child undernutrition, high morbidity and mortality [10]. Notably, food insecurity may influence inappropriate feeding practices in low-income areas [8]. Moreover, caregivers' inappropriate complementary feeding behaviour due to lack of nutrition knowledge on optimal feeding practices, inadequate awareness of the frequency of feeding and the quantity of food to be fed to the child, what constitutes a balanced diet, and cultural beliefs are modifiable factors that can contribute to the deterioration of a child's nutritional status [11]. Consequently, various nutrition-specific and nutrition-sensitive interventions were proposed by the World Health Organization (WHO) to improve maternal and young-child health/nutrition status in developing countries [12].

The most recent prevalence of stunting in Kenya (26.2%) is slightly above the average for developing countries (25%), however it's a reduction from 35% in the 2008-2009 Kenya demographic national survey (KDHS). A report by Kimani et al. on data collected in 2010 identified a prevalence of 46%, 11%, 2.5%, and 9% stunted, wasted, underweight and overweight, respectively, under-five children in Korogocho and Viwandani slums [13]. Similar findings were reported in 2011 with 47% stunted in the urban informal settlements of Kibera, 11.8% underweight and 2.6% wasted [14]. Recent studies conducted in urban informal settlements report a reduction in the prevalence of stunting and underweight children [15]. This success is attributed to extensive implementation of maternal and child health-related interventions and strategies. These include breastfeeding campaigns and personalized nutrition education and counselling (NEC) geared towards improvement of exclusive breastfeeding and complementary feeding practices [16,17]. However, the evidence supporting this hypothesis is limited, while the results of few studies thus far conducted in urban informal settlements in Kenya and other LMICs on the effect of maternal nutrition counselling on the linear growth and nutrition status of under-five children have been inconclusive.

For instance, previous systematic reviews have reported the effect of providing nutrition counselling, with or without nutritional support, on child's growth and development [18,19]. A nutrition education intervention delivered through the health centre in low income shanty towns in Peru, reports a greater proportion of stunting among the control group than the intervention group [20]. However, a similar study conducted in poor urban slums in Mumbai through household visits reports the effectiveness of nutrition counselling alone on increasing child energy intake but no significant improvement on children's length and weight gain [21]. A recent systematic review reporting the effects of different forms of nutrition interventions revealed inadequate effects of those interventions on child nutrition outcomes in the context of urban slums [22]. This contradictory findings are likely to emanate from differences in the duration and intensity of the nutrition counselling provided, the different set-ups for delivering education messages (health centre vs home-based), the mode of delivering nutrition education messages, differences in food security status in the study areas among others [20-22]. On the other hand, underlying conditions such as poverty, illiteracy, poor environmental factors, and inadequate resources explain lack of behaviour change [23]. Given this paradox, this study aimed to evaluate the difference in children's nutrition status among a community who received home-based NEC through the involvement of community health workers (CHW) and to identify the determinants of the child's linear growth whilst at the same time, counteracting the weaknesses observed in previous studies

3.2.1 Objective

This study aimed to determine whether the prevalence of stunting differed between an intervention group and a control group and to identify factors associated with the children's linear growth.

3.3 Methodology

3.3.1 Study design

This was a follow-up study of a mother-child cohort who initially participated in a cluster randomized controlled (RCT) [24]. The initial study was conducted under the Maternal Infant and Young Child Nutrition (MIYCN) project by the African Population and Health Research Center (APHRC) from 2012 to 2015. The experimental intervention involved personalized home-based nutritional counselling of pregnant women from the time of recruitment until the baby attained one year. The objective of the initial study was to assess the effectiveness of personalized, home-based nutrition counselling of women during pregnancy as well as its effect on infant feeding practices, morbidity, and nutrition outcomes within one year after delivery. Follow-up data from this cohort was collected in 2018. The main focus of this follow-up study was to assess the effect of NEC on children's linear growth while considering factors that may have been influenced by the initial study such as exclusive breastfeeding, complementary feeding practices and hygienic practices. Details on the initial cluster randomization and recruitment of the study participants were published in the trial protocol [24], and the effects of the intervention on exclusive breastfeeding practices has been published elsewhere [25].

3.3.2 Study setting

This study was conducted in two highly populated, Viwandani (52,583/km^2) and Korogocho (63,318/km^2), urban informal settlements (slums) of Nairobi, Kenya as already described in chapter 2. Data was collected from the 14 villages which exists in the two slums.

3.3.3 Study population

This was a cohort of pregnant women recruited during pregnancy and followed-up quarterly with their children until the 13th month after delivery and at the 55th month. The mother-child pairs who participated in the 2012–2015 RCT (first to fourth follow-up) were involved in the fifth follow-up.

Inclusion criteria

The initial study's inclusion criteria involved women of reproductive age, registered in the NUHDSS, who became pregnant in the year between 2012 and 2014, who voluntarily agreed to participate in the study. As a result, a total of 529 mother-child pairs who were exposed to NEC and 581 in the control group (not exposed) were available at birth for follow-up. However, at the 13^{th} month after delivery, only 215 and 221 mothers-child pairs in the intervention and control groups, respectively, were followed up as some were lost to follow-up or not traced, Figure 1.

The mother-child pairs who were still residing in the Korogocho and Viwandani slums, registered within the NUHDSS, and voluntarily agreed to participate, provided written informed consent and were included in the fifth follow-up.

Exclusion criteria

Involved mother-child pairs who participated in the initial study but migrated out of the study area, presence of chronic diseases, hearing and vision disabilities, and/or death of the index child. A total of 220 mother-child pairs in the exposed (intervention group) and 218 in the unexposed (control group) were traced and data was collected from them.

In addition, participants with missing information on child length/height were excluded from the data analysis. There were few cases (2.1%) of missing data regarding the outcome variable from the 2012-2015 follow-up and no cases of missing data in the 2018 follow-up. Baseline characteristics of children who dropped out during the study period did not differ with those analysed in this study.

3.3.4 Description of intervention and control groups

Details on the intervention package and the control group are already described in chapter 2, and more details were previously published [24,25]. The intervention group received counselling from trained CHWs who had a minimum of primary school education and had received basic training from the government. They were selected from the study site, 14 villages. The CHWs were trained by the APHRC using a package on Community Infant and Young Child Feeding (IYCF) adopted from the Kenya Government, Ministry of Health [26]. After delivery, the intervention group mothers were visited, their child's health checked, and counselled weekly during the first month after delivery and on a monthly basis until the infant turned one-year-old. Further, weekly counselling was conducted when the child was five months to prepare mothers for complementary feeding. A total of 17 counselling sessions were held after delivery. Key messages were imparted for exclusive breastfeeding and continued breastfeeding until the child was two years old, feeding infants an adequate and well-balanced diet, child feeding during illnesses, practicing child responsive feeding, home management of child vomiting and diarrhoea, practicing proper sanitation and hygiene when preparing child's food and during feeding the child, advocacy on postnatal clinic attendance for periodic immunization, weight monitoring, and vaccination of their children among others, **supplementary material Table S2.**

The control group received the usual antenatal care practices such as home-based counselling from the CHW on usual care (ante-natal care, family planning, skilled delivery, immunization), MIYCN reading materials. These CHW were not participating in the intervention and were not given any form of training on MIYCN [25]. The CHWs' visits to the control group households is a standard practice specified under the community health strategy of the Kenyan Government, Ministry of Health and is defined by the mother's need. This study was blinded by the fact that CHW in both study arms were to visit the mothers monthly. The CHWs were allocated women within their village of residence to visit. However, they did not know whether their village was an intervention or control group. The cluster randomization in the allocation of the villages to the study arm by a data analyst who was not part of the study team reduced the chances of contamination of the control group.

3.3.5 Data sources

The baseline data were collected during recruitment, and then the pre-birth data during the third trimester of pregnancy. Thereafter, the follow-up data were collected every three months from post birth one to post birth four. This was followed by a single observation in May 2018 (fifth follow-up) when the majority of the children were four and a half years old. Post birth three had three surveys at intervals of two months. Hence, data from the mother-child pairs were collected post birth when the mean age (SD) of the child was 1.4 (2.4), 4.4 (1.9), 7.3 (1.9), 9.5 (1.9), 11.0 (1.6) 13.5 (1.7), and 55.9 (5.3). Data used for the analysis of child health characteristics consist of 4062 observations of repeated measures from birth until the infant turned one year for both the exposed (intervention group) and unexposed (control group) and 438 during the fifth follow-up as described as described in (Table 3.1) and **Figure 3.1.**

3.3.6 The fifth follow-up data collection

Eight trained interviewers (four in the intervention group and four in the control group) were accompanied by two CHWs, who participated in the initial study and who were still residing in the same village. Households that participated in the initial study, and those who might have changed their residence were identified using existing household identification numbers issued during the quarterly surveillance by the NUHDSS. Others were identified by CHWs and interviewers who participated in the initial study.

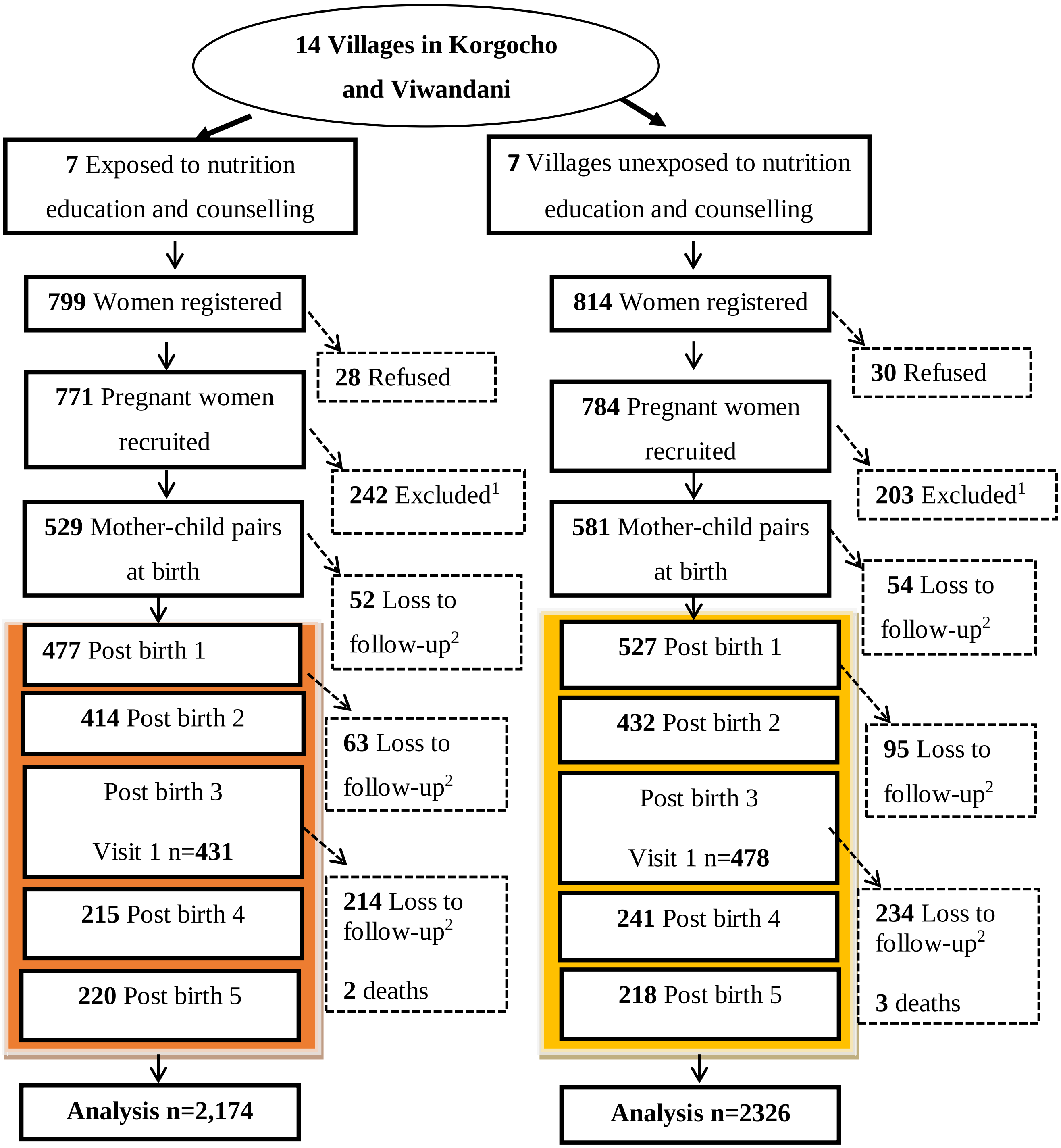

Figure 3. 1 Flow diagram of study participants included in the analysis

[1]Excluded or dropped due to loss to follow-up during pregnancy, migration or death of mother, giving birth before receiving the intervention and pregnancy loss (miscarriage/abortion or still

birth).[2]Lost to follow up after giving birth due to out migration, untraced cases, death of mother or the baby and exit from study

The recruited mothers confirmed that they had participated in the initial study and received a detailed explanation of the study details before giving written informed consent. Data were collected one village at a time from each mother-child pair using a hand-held android tablet containing a semi structured pretested questionnaire installed in SurveyCTO collect software version 2.50. The questionnaire consisted of three parts: a general questionnaire for sociodemographic and socioeconomic information of the households and caregivers, previous breastfeeding, and complementary feeding practices of the index child, health practices such as vaccination, morbidity experience of the child, maternal and child anthropometric measurements.

3.3.7 Anthropometric Measurements

Anthropometric measurements were taken by experienced interviewers who received training on anthropometric measurements based on guidelines recommended by the Centers for Disease Control and Prevention (CDC). Child's age was calculated in months from the birth date using clinic cards and birth certificates as reference. Child's sex was observed physically during examination. While birth weight was recorded from clinic cards and mothers' recall for those who had misplaced the clinic booklet/card.

During infancy, a length board was used to take two measurements of the infant's recumbent length to the nearest 0.1 cm while the infant was lying in a supine position. Subsequently, during the fifth follow-up, a height board was used to collect the child's height to the nearest 0.1cm while the child was standing. The infant's mother and the CHW in charge of the village assisted the interviewer in positioning the child as advised by the interviewer to ensure measurement reliability and validity. Infant's weight was obtained by subtracting the weight of the mother who was carrying the infant during weight measurement from the weight of the mother alone. Children who could stand were weighed twice, using electronic scales, in minimum clothing and the measurements were recorded to the nearest 0.1kg (SECA876; SECA, Germany).

An average of the two readings for length/height was used to compute the length/height -for-age (LAZ/HAZ) scores at each measurement point to assess stunting using the WHO growth reference standards by the z anthro command in STATA. This LAZ/HAZ score index is an indicator of linear growth with cut off points to assess retardation and cumulative growth deficits in children. The WHO cut-offs were used to determine child nutrition status. Children with a LAZ/HAZ score of <-2SD were considered stunted [27].

An SECA stadiometer was used to take two readings of the mother's height to the nearest 0.1 cm, while an electronic scale (SECA876; SECA, Germany) was used to take the mother's weight to the nearest 0.1 kg. From the two readings, an average value was computed and used as the weight and height of the mother to reduce the measurement error. The mother's BMI was calculated using her weight divided by her squared height (kg/m^2). Their nutrition status was categorized as underweight, normal, overweight, or obese based on the WHO cut off values [28].

3.3.8 Study variables

The primary outcome was children's stunting prevalence (LAZ/HAZ score of <-2 SD). The predictor variable was study group (intervention or control), while the covariates were infant breastfeeding and responsive feeding practices, child characteristics (term birth weight, weight for age, sex, morbidity experience) and maternal characteristics (village of residence, total income, level of education, occupation, household size, parity, marital status, and hygiene practices) as guided by existing literature and conceptual frameworks [7,8].

3.3.9 Statistical analysis

Child linear growth from the first to the 13th month was analysed separately with the 55-month follow-up because of the big time lag. There were a few cases of missing data (<2.1%) regarding the outcome variable, Table 2, therefore imputation of the missing data was not performed. Descriptive statistics (proportions for categorical and means for continuous variables using chi-square and t-tests, respectively) were used to report maternal and child characteristics between the study arms at different follow-ups. Correlation coefficients were checked for covariates. A linear mixed-effects model was used to fit LAZ/HAZ scores, as it takes account of correlations among repeated measures from the same child/household [29].

The subject (child) was modelled as a random effect while the study group was modelled as a fixed parameter. Child birthweight, breastfeeding, age at weaning, child feeding, maternal height, among others were added as fixed covariates of the child linear growth model. Model building involved several steps and the selected covariates in the final model were based on existing literature, results of the regression outputs and testing for collinearity. Different regression diagnostics were performed to assess the model goodness of fit and multicollinearity. Generalized linear model using generalized estimating equations were used to compare the findings of the linear mixed-effects models, **(supplementary material Table S3)**. Preterm children were excluded from the final model. Statistical analysis was conducted using IBM SPSS version 24. Statistical significance was considered at $p < 0.05$.

3.4 Results

3.4.1 General characteristics of the mothers

There were no statistical differences observed between the control group and the intervention group regarding their socioeconomic and demographic characteristics at baseline and at the fifth follow-up, except for ethnicity, (Table 3.2). However, a change was observed in age group, school attendance, parity, occupation, weight, height, and BMI of the women when the baseline and the fifth follow-up sociodemographic characteristics were compared. The mean (SD) weight of the mothers increased from 63.5 (10.7) kg at baseline to 68.9 (14.7) kg during the fifth follow-up. A mean height difference of 2 cm was observed between the baseline, 158.6 (8.0) cm, and the fifth follow-up, 160.4 (5.6) cm, probably as a result of 16% women aged less than 18 years old, with a range of 12-49 years old, during baseline data collection or technical measurement error.

3.4.2 Child health characteristics, responsive complementary feeding and hygiene practices

Child health characteristics after birth are reported in (Table 3.3). During the first follow-up after birth, mothers in the intervention group reported having delayed the introduction of complementary foods by 19 days as compared with those in the control group. Moreover, significantly higher proportions of mothers positively encouraging the child to finish food were reported in the intervention group than in the control group (58.0% vs 42%) during the post-infancy period (18 months' follow-up). During the third follow-up, a significantly higher proportion (61.1% vs 56.2%) of mothers in the control group reported stopping feeding their child once they refused to eat, a similar trend was observed post infancy, with 55.5% of mothers in the control group vs 46.7%. Besides, significantly more mothers in the control group (32.6% vs 28.2%) reported changing the texture of the food. In addition, significantly more children (13.4%) in the control group than the intervention group (8.8%) experienced food regurgitation/vomiting during feeding. Data on responsive feeding were not collected during the fifth follow-up as most of the children could feed by themselves, (Table 3.3).

Good sanitation and hygiene practices were not common among the control group. For example, during the third and post-infancy follow-ups, the proportion of mothers who reported disinfecting utensils used for feeding their children was significantly higher in the intervention group (56.8% and 32.1%, respectively) than in the control group (44.8% and 21.2%), respectively. The proportion of mothers who reported using a cup/bowl and spoon to feed the child was also significantly higher in the intervention group (61.0%) than in the control group (56.2%). Only 6.5% of the women reported using their palms/hands to feed their children, with more reported in the control group (8.2%) than in the intervention group (4.8%). During the fifth follow-up, about 44.5% of the study participants paid a fee to use a toilet facility (35.3% in the control and 53.6% in the intervention), while 90.9% paid for drinking water, with the majority (60.0%) buying it from a tap water kiosk. Significantly more mothers in the intervention group reported to often (47.3%) and sometimes (41.4%) practice proper infant feeding practices as taught by CHW as compared to 21.6% and 44.5%, respectively in the control group.

3.4.3 Child linear growth and prevalence of stunting

The LAZ scores decreased from birth to the 13th month, a mean (SD) of -1.42 (2.04), with significantly higher stunting prevalence in the control group (33.5%) than the intervention group (28.6%). Moreover, male children were significantly stunted in comparison with the female children. Conversely, the scores increased in the 55th month, a mean (SD) of -0.89 (1.04), with 13.9% stunting prevalence in the control group and 11.1% in the intervention group and significantly more males were stunted in the control group (16.5%) than the intervention group (8.3%). At the age of seven and 13 months, children in the intervention group were reported to be taller by 0.47 cm and 0.72 cm, respectively, compared with the children in the control group, while the boys were reported to be slightly taller throughout the follow-ups. A significantly higher (-10%) difference in stunting was observed between the intervention and control groups at the nine months' visit. Consecutively, at 13 months old, a higher proportion of children were stunted in the control group than in the intervention group, (Table 3.4). Figure 2 shows the LAZ/HAZ scores plotted against their age to show their growth pattern considering the study group and sex.

3.4.4 Factors associated with children's linear growth in mixed-effects models

A fully adjusted linear mixed-effects model was fitted for all the children with LAZ/HAZ scores from the first to the fifth follow-up, (Table 3.5). Children in the control group, those living in the Korogocho informal settlements, were less likely to grow taller than were those in the intervention group and Viwandani informal settlements. Child factors such as being male, often regurgitating/vomiting food after feeding, being introduced to complementary foods before six months, and maternal factors such as shorter stature were associated with lower LAZ/HAZ scores. However, term children born with normal birth weight (>2.5kg), fed slowly or at a moderate pace, and breastfed longer, were more likely to grow taller than their counterparts. Interestingly, a positive association was found between women who reported washing their hands before handling their child's food and the child's linear growth.

3.5 Discussion

Child stunting patterns and factors associated with their linear growth were assessed in this follow-up study of children born between 2012 and 2014 in two of Nairobi's urban informal settlements. A high prevalence of stunting at one-year-old was observed. However, a vast improvement was observed during the fifth year of follow-up when the average age of the children was four and a half years. This stunting pattern is common among children under five in LMICs, with many studies reporting the highest stunting rates at two years of age [30,31]. Using new WHO standards on a sample of 1000 to 47,000 children from 54 countries measured from birth, Victora et al. (2010) [31] reported that the child's length/height falters dramatically until 24 months and increases slightly after 24 months, with bumps at 36 and 48 months. Moreover, a recent publication [32] whose participants were children born earlier (2007-2012) in the two study sites (Korogocho and Viwandani) reported significantly more stunted children in Korogocho and maximum growth faltering in length at two years, after which a modest recovery was observed up to five years of age.

Significantly more stunting prevalence was observed in the control group than in the intervention group throughout the follow-up period. Consequently, personalized home-based nutrition education and counselling of pregnant and lactating women by trained CHWs improved maternal nutrition status during pregnancy and after delivery, reduced low birth weight and preterm delivery of the children in the intervention group as reported in another publication based on the initial study [33] reduced their morbidity, created awareness on appropriate infant feeding practices, and promoted proper hygiene practices. Moreover, more children were reported to have the minimum meal frequency in the intervention group than the control group as already published [34]. Previous studies have reported comparable findings [20,35,36]. For instance, a study in Pakistan reported a lower prevalence of growth faltering among the intervention group following nutrition counselling of mothers by trained health workers [37]. A study conducted in India [38] reported that intensive nutrition education and counselling of caregivers can increase meal frequency and improve the quality of food fed to children living in the urban slums of Mumbai. Therefore, on the basis of these previous studies, the likelihood exists to improve infant feeding practices and their nutrition status through the provision of maternal nutrition education interventions by trained CHWs [19,39].

Although the difference in stunting proportions between the control and intervention groups was significantly higher in the first four follow-ups, a reduction in the prevalence of stunting during the 55th month follow-up was observed with a significant difference between the study arms observed among the male children. This finding is similar to the most recent (2019) prevalence of stunting (14.5%) among children observed up to five years old in these slums [32] and a prevalence of 17% for children under five in the whole of Nairobi based on 2014 KHDS [40]. The reduction in the prevalence of stunting during the fifth follow-up may be explained by the fact that maximum stunting rates are achieved at two years old after which the child tries to recover their height up to the age of five years [32]. Faye et al. reported an incidence of 45% stunting recovery among children from these slums with the median age of recovery being 50 months [41]. Another possible explanation is that the APHRC implemented a project in 2015 of giving vouchers (to subsidize the cost of taking their child to a day care facility) to mothers with children aged one to three years old in the control and intervention groups [42]. This could have resulted in improved child feeding and their nutrition status because their mothers had time to engage in some income-generating activities. Hence, the majority of the mothers were either in casual employment or undertaking small business activities and their monthly income increased [42] as also evidenced in the occupation status during the fifth follow-up as compared with the baseline.

Various factors identified to be negatively or positively associated with LAZ/HAZ score have been reported in other studies. For example, studies in Indonesia reported LBW as the leading cause of stunting [9]. Low birth weight may result from IUGR, which emphasizes the need to initiate interventions prenatally to address child malnutrition. In the same paper and previous publications, boys are more likely to be stunted than girls, which also compares with the KDHS findings with higher levels of stunting among boys than girls [40]. Biologically, it is well known that girls tend to grow faster than boys during early childhood and they require fewer nutrients [43]. Notably, a significant difference in stunting between the two study groups was observed among boys but not among the girls. An exploration of already published [44] baseline qualitative data on breastfeeding from the initial study has probable explanatory responses. Mothers reported introducing complementary feeds to boys earlier than 6 months and could not practice continued breastfeeding up to two years like they do for girls due to a common belief that boys breastfeed 'a lot' and 'weaken' their mothers [44]. However, some studies have recommended exclusive breastfeeding and continued breastfeeding as a predictor of better linear growth [32,45] because of it is a protective factor against child morbidity such as diarrhoea cough or wheeze, and vomiting [46]. In addition, previous studies that included child responsive feeding messages in the nutrition education package reported women in the intervention group actively encouraged their children to eat at 9 and 18 months. As a result, a positive effect of the intervention on children's dietary intake and growth was reported [20,47,48]. However, the independent effect of responsive feeding was not determined in these studies. Besides, maternal short stature is a known cause of child linear growth retardation [7], while good hygiene practice like washing hands before handling child food [49] is documented as a preventive measure against common illnesses in children such as diarrhoea and vomiting which causes nutrient loss and is associated with deteriorating child's linear growth if it recurs [50].

3.5.1 Study strengths

The strengths of this study are that the initial study was a large and well-organized and monitored randomized controlled study, the CHWs were well trained and supervised, and the data were well managed, thereby increasing their reliability. Moreover, to the best of our knowledge, it is the first randomized controlled trial of a personalized home-based nutrition education intervention for maternal and young child nutrition and complementary feeding practices in urban informal settlements in Kenya. Additionally, this study is the first follow-up to assess and report the effect of NEC on stunting prevalence among this population after five years of study completion.

3.5.2. Study limitations

The limitations include: the study population is an urban informal settlement, which to some extent limits the generalization of the results to the whole country; however, generalization to similar impoverished settings is possible. Secondly, there was a high loss to follow-up. This trend is noted in most studies conducted in urban slums owing to high out-migration. However, the loss to follow-up baseline characteristics did not differ from those included for analysis. Thirdly, the intervention group was routinely visited according to the counselling schedule, while the control group was routinely visited by the interviewers for measurements as for those in the intervention group. Moreover, CHWs also visited the control group according to the usual practice specified within the community strategy. Therefore, it is not possible to rule out a potential for Hawthorne effect and contamination across the study participants given the nature of the intervention which involved knowledge transfer. However, since both mothers were visited by CHWs, the cluster randomization and blinding effect reduced the chances of contamination of the controls. Fourthly, mothers might have given desired answers concerning child feeding practices due to social desirability in the context of an intervention. Conversely, the interviewers asked a lot of questions longitudinally regarding child feeding practices and were trained on probing to justify the answers given. Lastly, child's linear growth between 13-55 months was not assessed as height measurements were not taken.

3.6 Conclusion

According to this study's findings, providing maternal nutrition education and counselling during pregnancy and one year after delivery reduced stunting prevalence in the first and fifth year of life, with significantly lower rates of stunting observed among boys in the intervention group as compared to the control group. This could have resulted because of better responsive feeding practices, good hygiene practices, and less morbidity among children born to mothers in the intervention group than among those born in the control group. Further scale-up of household-based nutrition education and counselling needs to be evaluated by governments in urban informal settlements or similar high-risk areas.

3.7 References

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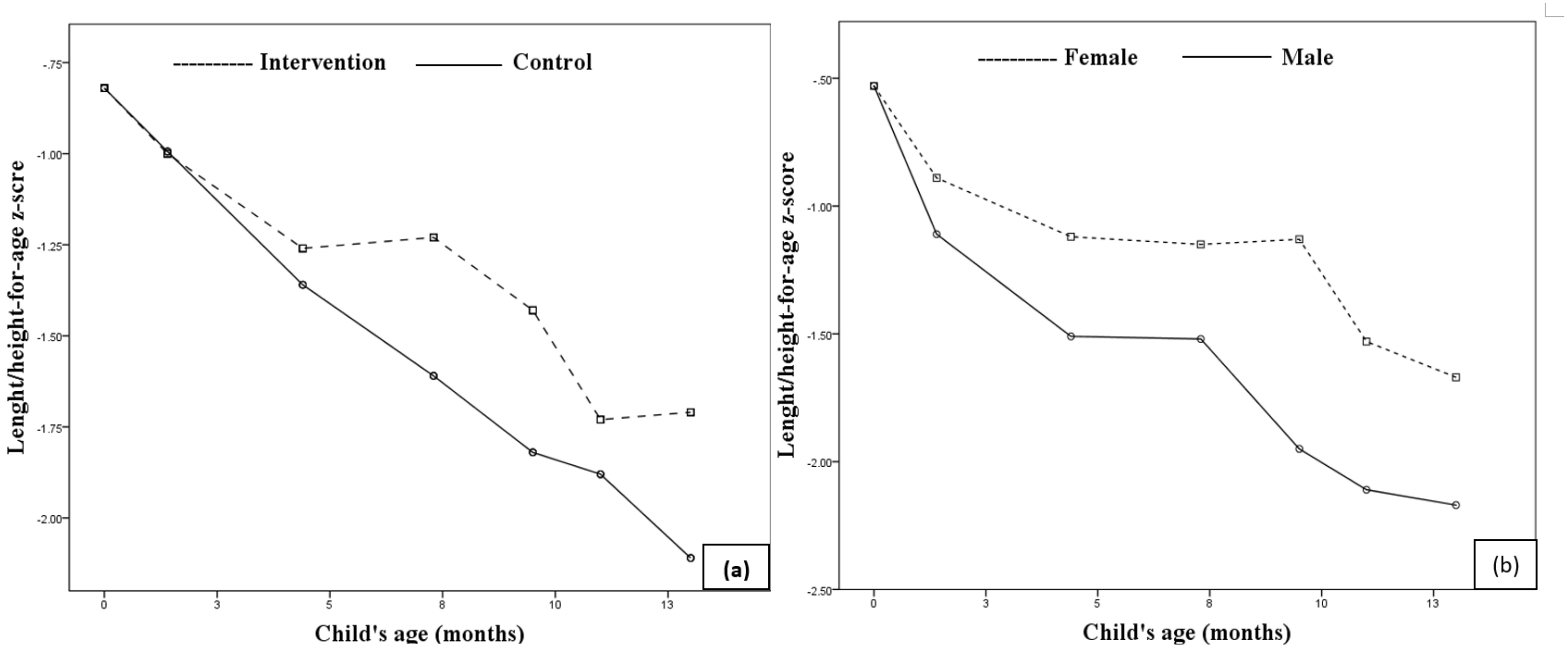

Figure 3. 2 Variation of child's length/height-for-age z-score for (a) study group and (b) gender, from birth to 13th month.

(a) ------, intervention, ————— , control (b) ------ , female ————— , male

Table 3. 1 Number of participants at each follow-up

Follow-up period	Post birth 1	Post birth 2	Visit 1	Post birth 3 Visit 2	Visit 3	Post birth 4	Post birth 5
Child mean (SD) age in months	1.4 (2.4)	4.4 (1.9)	7.3 (1.9)	9.5 (1.9)	11.0 (1.6)	13.5 (1.7)	55.9 (5.3)
Control (n)	527	432	478	280	150	241	218
Intervention (n)	477	414	431	261	156	215	220

Table 3. 2 General characteristics of the mothers by study group in each follow-up

Variable category	Baseline at enrolment (2012)			5th follow-up (2018)		
	Control n= 770 n (%)	Intervention n=760 n (%)	P-value	Control n=218 n (%)	Intervention n=220 n (%)	P-value
Age group						
14-20	222 (28.8)	223 (29.3)		5 (2.3)	1 (0.5)	
21-30	446 (57.9)	458 (60.3)	0.218	116 (53.2)	131 (59.5)	0.135
31-50	102 (13.3)	79 (10.4)		97 (44.5)	88 (40.0)	
School attendance						
Preschool	131 (17.0)	119 (15.6)		13 (6.0)	5 (2.2)	
Primary	450 (58.4)	429 (56.5)		132(60.6)	119 (54.1)	
Secondary	171 (22.3)	186 (24.5)	0.131	66 (30.3)	84 (38.2)	0.055
College	18 (2.3)	26 (3.4)		7 (3.1)	12 (5.5)	
Occupation						
Unemployed	561 (72.8)	544 (71.6)		85 (39.0)	86 (.39.1)	
Casual labour	95 (12.4)	97 (12.8)	0.345	79 (36.3)	72 (32.7)	0.532
Own business	92 (12.0)	95 (12.4)		46 (21.0)	50 (22.7)	
Salaried	22 (2.8)	24 (3.2)		8 (3.7)	12 (5.5)	
Marital status						
Married	639 (83.0)	606 (79.7)	0.431	157 (72.0)	180 (81.8)	0.067
Unmarried	131 (17.0)	154 (20.3)		61 (28.2)	40 (18.2)	
Religion						
Christian	701 (91.0)	700 (92.2)		192 (88.0)	210 (95.4)	
Muslim	65 (8.5)	40 (5.2)	0.631	23 (10.6)	7 (3.2)	0.081
Other	4 (0.5)	20 (2.6)		3 (1.4)	3 (1.4)	
Ethnicity						
Kikuyu	200 (26.0)	217 (28.6)		67 (30.7)	61 (27.7)	
Luhya	159 (20.7)	133 (17.5)		44 (20.2)	34 (15.5)	
Luo	111 (14.4)	125 (16.5)	0.180	29 (13.3)	57 (25.9)	0.002
Kamba	156 (20.2)	148 (19.4)		42 (19.3)	36 (16.4)	
Others	144 (18.4)	137 (18.0)		36 (16.5)	32 (14.5)	
Maternal BMI						
<18.5	10 (1.3)	10 (1.3)		7 (3.3)	5 (2.3)	
18.5-24.9	405 (52.6)	406 (53.4)	0.172	76 (34.7)	84 (38.1)	0.845
25.0-29.9	279 (36.2)	244 (32.2)		87 (39.9)	83 (37.6)	
30 and more	76 (9.9)	100 (13.1)		48 (22.1)	48 (22.0)	
Parity						
0-1 child	516 (67.0)	537 (70.7)		51 (23.4)	40 (18.2)	
2 children	127 (16.5)	119 (15.6)	0.26	66 (30.3)	82 (37.3)	0.213

3 or more	127 (16.5)	104 (13.7)		101 (46.3)	98 (44.5)	
Total monthly income in Kenyan Shilling						
<4000	136 (17.7)	170 (22.4)		52 (23.8)	43 (19.5)	
4000-6999	223 (29.0)	214 (28.2)	0.722	47 (21.6)	44 (20.0)	0.423
>7000	411 (53.3)	376 (49.4)		119 (54.6)	133 (60.5)	

BMI: body mass index

Table 3. 3 Child health characteristics by study group and follow-up

Variable‡	Follow-up 1st to 4th†				5th follow-up			
	Control n=2108		Intervention n=1954		Control n=218		Intervention n=220	
	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %	Mean or n	SD or %
GA at birth in weeks	38.1	3.9	38.6	3.8*	38.4	3.0	38.7	4.2
Mean birth weight (kg)	3.2	0.5	3.2	0.5	3.3	0.6	3.2	0.6
Low birth weight, n (%)	35.0	6.7	12.0	2.5*	13	6.0	7.0	3.2
Infant sex, male, n (%)	1081	51.3	961	49.2	126	57.8	102	46.4
EBF (self-reported), n (%)	1096	52.0	938	48.0	186	85.3	190	86.4
Age of CF for those not EBF	5.21	2.5	5.47	5.8	3.0	1.5	3.4	1.6
Common morbidity n (%)§	n=1775		n=1692					
Cough	290	16.3	235	13.9*	67	30.7	61	27.7
Fever	194	10.9	144	8.5*	42	19.3	51	23.2
Diarrhoea	174	9.8	165	9.8	45	16.1	28	12.7
Mother wash hands before handling food	185	10.4	418	24.7**	90	41.5	104	47.5*
Mother wash hands before feeding child	-		-		45	20.7	64	29.2*
Pace of child feeding n (%) ‖	n=1037		n=976					
Fast pace	80	7.7	50	5.1	¶-		-	
Moderate pace	595	57.4	695	71.2***	-		-	
Slow pace	362	34.9	231	23.7	-		-	
Child often vomits/regurgitates food ‖	139	13.4	85	8.8**	-		-	
Encourages baby to finish food positively‖	372	35.9	434	44.5**	-		-	
Promise baby a reward if they finish food ‖	50	4.8	88	9.0**	-		-	
Refocus baby's attention with play ‖	326	31.4	346	35.4*	-		-	

GA, gestational age; EBF, exclusive breast-feeding; CF, complementary feeding.

*P < 0·05, ** P < 0·01, ***P < 0·001.

†Observations at 1, 4, 7, 9, 11 and 13 months old.

‡Continuous variables are presented as mean and SD; categorical variables are presented as numbers and percentages.

§Data were collected when the child was 1, 4, 7, 9 and 11 months old.

||Data were collected when the child was 7, 9, 11 and 18 months old.

¶Information was not collected as the children could feed themselves.

Table 3. 4 Child mean length, LAZ/HAZ-score, and prevalence of stunting by follow-up and study group

Variable*	Control Mean or n	Control SD or %	Control Total n	Intervention Mean or n	Intervention SD or %	Intervention Total n	95% CI	P-value
LAZ (1-13 month)	-1.51	2.09	1868	-1.31	1.96	1737	-0.03,-0.07	0.003
Male stunted	432	40.0	949	301	31.4	853	-	<0.001
Female stunted	275	26.8	919	257	25.9	884	-	0.359
Total stunted	707	33.5	1868	558	28.6	1737	-	0.001
Missing	28	1.5		50	2.8		-	
HAZ (55 month)	-0.83	1.03	218	-0.73	1.06	220	-0.12,0.33	0.361
Male stunted	21	16.5	126	8	8.3	102	-	0.045
Female stunted	9	9.9	92	16	14.3	118	-	0.386
Total stunted	30	13.9	218	24	11.1	220	-	0.226
Mean (SD) length and height in cm								
1 month	53.54	4.32	527	54.04	5.33	477	-1.13, 0.17	0.145
% stunted	142	27.0		112	23.4			0.126
4 months	60.62	4.21	432	60.63	3.81	414	-0.62, 0.54	0.892
% stunted	121	28.0		117	28.1			0.493
7 months	64.98	4.38	478	65.45	3.91	431	-1.07, 0.13	0.122
% stunted	162	33.9		127	29.5			0.116
9 months	67.56	3.98	280	67.95	3.46	261	-1.01, 0.24	0.228
% stunted	112	40.1		78	30.0			0.009
11 months	69.12	3.93	150	69.43	2.90	156	-1.11, 0.47	0.429
% stunted	57	37.9		49	31.3			0.148
13 months	71.32	3.51	241	72.04	2.72	215	-7.41, 4.74	0.638
% stunted	109	45.4		75	34.5			0.015
55 months	103.90	4.73	218	103.44	4.73	220	-0.43, 1.34	0.314

*Continuous variables are presented as mean and SD and CI; categorical variables are presented as numbers and percentages.

Table 3. 5 Factors associated with children's linear growth from linear mixed-effects model

Fixed effect parameter	Coefficient (β)	SE	95% CI	P-value
Intercept	-0.82	0.201	-1.22, -0.43	<0.001
Study group (ref. Intervention)				
Control group	-0.21	0.096	-0.39, -0.02	0.031
Study site (ref. Viwandani)				
Korogocho	-0.73	0.181	-0.11, -0.30	0.001
Child sex (ref. Female)				
Male child	-0.52	0.095	-0.71, -0.33	<0.001
Full term birth weight (ref. LBW)	0.68	0.240	0.14, 1.08	0.011
Child is still BF above 1 year old	1.07	0.438	0.21, 1.93	0.015
[a]Early weaning, before 6 months	-0.48	0.071	-063, -0.35	<0.001
Usual pace of child feeding (ref. Fast)				
Slow	0.49	0.206	0.09, 0.89	0.016
Moderate	0.81	0.197	0.42, 1.20	<0.001
Child often vomits/regurgitates food (ref. No)	-0.66	0.148	-0.95, -0.73	0.001
Caregiver washes hands before handling baby food (ref. No)	0.34	0.146	0.14, 0.53	0.001
Mother's height (ref.>163cm)				
<154.5 (<25th Percentile)	-0.69	0.138	-0.63, -0.16	0.001
154.5-163 (50th Percentile)	-0.13	0.115	-0.36, 0.10	0.272

LBW, low birth weight; BF, breastfeeding, CF, complementary feeding

[a]Early weaning was defined as the introduction of complementary foods before 6 months

CHAPTER 4: Prevalence and Determinants of Anaemia Among Pre-School Children

4.1 Abstract

Urban slums are informal dwellings which are inhabited by poor and low-income families; Nairobi Metropolitan has a fair share of such dwellings of varying sizes. Slums may pose risk to child health and nutrition due to food insecurity, poverty, poor hygiene, and sanitation. Helminth infestation and infectious diseases are rampant. This study assessed the prevalence and determinants of anaemia five years after implementing a nutrition education and intervention.

A cross-sectional study was conducted in May 2018 as a follow-up of a randomized controlled study carried out between 2012-2015 in Korogocho and Viwandani slums of Nairobi. Information on child feeding, morbidity, nutrition status, sanitation, and maternal characteristics was collected from 438 households which participated in the initial study. Children's haemoglobin levels were measured by a trained nurse. Multiple linear regression was conducted to identify determinants of haemoglobin levels.

The mean (SD) age of the children was 55.9 (5.3) months and mean (SD) haemoglobin was 10.7 (1.5) g/dL. Anaemia prevalence was 59.8%, with 33.9% mildly, 24.7% moderately, and 1.2% severely anaemic. Total anaemia prevalence was similar in both groups (59.3%, intervention vs 60.2%, control). Absence of home toilet [(β= -0.15 (95% CI; -1.31, -0.14)], <5 minutes' walk to shared toilet [(β= 0.16 (95% CI; 0.07-0.76)], fully immunized child [(β =0.14 (95% CI; (0.19, 3.47)], frequency of eating coloured fruits and vegetables [(β =0.13 (95% CI; (0.01, 0.17)], meat and meat products [(β =0.15 (95% CI; (0.03, 1.04)], non-anaemic mother [(β= 0.21 (95% CI; (0.79, 3.36)], child mid-upper arm circumference [(β =0.16 (95% CI; (0.06, 0.40)] were associated with child haemoglobin levels.

Urban informal setting environment influences child anaemia status. As a result, maternal nutrition education and counselling did not have an effect in reducing anaemia among children in their fifth year of life. This may be due to the time difference between the intervention and anaemia testing, minimal knowledge retention or other underlying risks. Further studies are required with intervention on improved sanitation facilities and access to meats, fruits, and vegetables in urban slums.

4.2 Introduction

Anaemia is a significant reduction in haemoglobin concentration, haematocrit, or the number of circulating red blood cells at a level below what is considered normal for age, sex, physiological state, and altitude [1]. It has adverse health consequences to preschool children include: poor immune function leading to increased risk of illness or susceptibility to infections, decreased responsiveness/activity, increase in body tension and fatigue, altered cognitive function, impaired motor development and growth, poor school performance and reduced productivity [2]. Globally, one in four people are affected with the highest prevalence recorded in sub-Saharan Africa (67.6%) and among preschool children (47.4%) [3,4]. In Kenya, about 43.2% to 46.0% of preschool children were found to be iron deficient in a national survey conducted in 2014 [5]. However, the prevalence in western Kenya was much higher with 71.8% moderate anaemia and 8.4% severe anaemia among children aged 6-35 months. Of these cases, 16.8% were associated with malaria, 8.3% iron deficiency, and 6.1% inflammation [6].

Iron deficiency due to inadequate dietary intake of iron-rich foods is the most common form of anaemia. Other direct risk factors include intestinal parasites, malaria, diarrhoea, HIV, and nutrient interactions leading to iron malabsorption. In addition, maternal income, education level, household size are also indirectly associated with anaemia [5]. Urban slums, informal dwellings inhabited by poor and low-income families, have many of these aforementioned risk factors. Moreover, there is high poverty rates, food insecurity, poor sanitation, and high infections which may increase vulnerability to iron deficiency, the highest prevalence being among the children and pregnant women. Therefore, the dwellers are vulnerable to iron deficiency, highest prevalence being among the children and pregnant women. In addition, vulnerability of preschool children is aggravated by poor feeding due to low nutritional knowledge of mothers.

Studies have reported high anaemia prevalence [7] and tested interventions to address this major public health problem among preschool children since iron requirements increase between 6-59 months of age as their growth is rapid [8]. Majority of these studies recommend iron supplements, iron fortification and foods rich in iron. Though the evidences are uncertain, some studies suggest that unmonitored iron supplementation has its own risks such as increasing the severity of infection as many pathogens need it for their survival [9]. Alternatively, nutrition education and promotion of good dietary practices may increase intake of a variety of foods that can increase iron bioavailability in the body [10]. Moreover, general nutrition education and counselling, which includes messages on good hygienic practices and deworming, may indirectly impact on the reduction of iron deficiency anaemia. However, there are inconclusive findings from previous studies [11,12]. Hence, there's paucity of evidence on effects of maternal nutrition counselling on child health. This study was therefore designed to evaluate the effect of maternal nutrition education and counselling on the prevalence of iron deficiency among pre-school children in urban informal settlements of Nairobi.

4.2.1 Study objective

To assess the prevalence and determinants of anaemia five years after implementing nutrition education and counselling in urban informal settlements of Nairobi.

4.3 Methodology

4.3.1 Study design

This was a cross-sectional study conducted as a follow-up of mother-child pairs who participated in a randomized controlled trial (RCT) called Maternal Infant and Young Child Nutrition (MIYCN) (registration: ISRCTN83692672). The present study traced these mother-child pairs, who participated in the 2012-2015 RCT (initial study), from their respective households which are registered in the Nairobi Urban Health and Demographic Surveillance System (NUHDSS).

In the initial study, pregnant women were recruited from two slums in the following manner. A total of 14 villages were randomly assigned as an intervention or control group. These women were assigned to either receive monthly nutrition education and counselling from an MIYCN trained CHW or standard antenatal care from non-MIYCN trained CHW, trained on standard care, depending on the village they resided and the allocation of that village. After delivery, the mother-child pairs continued to receive the training on a weekly basis for the first 4 weeks and on a monthly basis until the child turned one-year-old. Details of the nutrition education and counselling were described in chapter two and published in the initial study's trial protocol and other papers [13,14]. Most of the information shared was geared towards promotion of exclusive breastfeeding, proper infant complementary feeding practices, and good hygienic practices. There were no specific messages addressing the need to reduce iron deficiency anaemia, however advice was given on what constitutes a balanced diet.

4.3.2 Study setting

This study was conducted in two of the most densely populated slums in Nairobi: Korogocho and Viwandani as earlier descried in chapter 2. The population of the slums increased from 30,021 in Korogocho and 37,825 in Viwandani in 2003 to 36,276 in Korgocho and 52,689 in Viwandani as of 2018 [15].

4.3.3. Study participants

The study participants were preschool children with their mothers as respondents. Mother-child pairs who participated in the initial project (MIYCN) were traced and recruited to participate in this study. Permanent household identification numbers were used to trace mother-child pairs who participated in the initial study. Community health workers (CHWs) involved in the initial study aided the interviewers in tracing and confirmation of the study participants. The inclusion criteria were mother-child pairs registered within the Nairobi NUHDSS, still residing in Viwandani and Korogocho slums, and willing to participate voluntarily by providing written informed consent. While mother-child pairs who had migrated out of the two study sites, children with underlying medical conditions or were sick during data collection, and those mothers whose children had died were excluded from the study. A total of 220 mother-child pairs who had received nutrition education and counselling, while 218 controls were traced and provided data for this study.

4.3.4 Data collection and measurements

Eight interviewers, two nurses, and CHWs who had participated in the initial study were involved in this study’s data collection. Each study site had four interviewers, one nurse and a CHW who resided in that village. The interviewers collected socio-demographics, economic and health characteristics from each traced household, one village at a time. Hand-held android tablets containing a semi-structured pretested questionnaire, installed in SurveyCTO collect software version 2.50, were used for data collection. While the nurses contacted each interviewer to measure haemoglobin (Hb) from the identified child in that given village.

Child anthropometrics measurements such as weight and height were taken based on guidelines set by the World Health Organization (WHO). An average of the two readings for length/height and weight was used to calculate length-for-age (LAZ) and height-for-age (HAZ) scores at each measurement point to assess stunting using the 2000 CDC growth reference standards by z anthro command in STATA [16,17]. Children with a weight-for-age (WAZ) z-score or body mass index (BMI)-for-age (BAZ) of <-2SD were considered underweight, while those with a BAZ score or weight-for-height (WHZ) scores of $\geq$ 2SD and were considered overweight/obese [18].

Children's Hb levels were measured using the HemoCue® HB 301 [19], a device designed for quick analysis of capillary blood Hb. The nurse ensured that the child settled down, wiped his/her fingertip with a cotton swab containing alcohol. The nurses collected a drop of venous blood by venepuncture from each child using a BD microtainer contact-activated lancets. Curvets were used to collect the drop of blood from the prick and inserted into the hemocue analyser. Haemoglobin and haematocrit levels were read and recorded by the nurse and the interviewer. Children with haemoglobin Hb <110 g/L were considered anaemic, while 100-109 g/L, 70-99 g/L and <70g/L were considered as mildly, moderately and severely anaemic, respectively.

4.3.5 Research ethics

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by Kenyatta National Hospital/University of Nairobi Ethics and Research Committee (KNH-UoN ERC) and by the ethical committee, Faculty of Medicine, University of Tsukuba. The Kenya Medical Research Institute (KEMRI) approved the initial randomized controlled study (2012-2015). The index child's mother was requested to voluntary give assent for data collection involving their child after a detailed explanation of the study purpose, benefits, risks, confidentiality, and compensation. Written informed consent was obtained from the mother. Mothers whose children were severely anaemic were referred to the nearest health facility with the assistance of the CHW from that village. While those with moderate anaemia received a brief counselling on recommended diet to improve their child's haemoglobin.

4.3.6 Statistical analysis

Descriptive statistics (means for continuous variables, proportions for categorical variables) were performed to report demographic, socio-economic, household factors, mother-child pair characteristics, morbidity, and hygienic practices. Variables related to the children included in the analysis were: age, gestation age at birth, gender, birth weight, and their nutritional status. Maternal characteristics included were: age, education level, occupation, marital status, religion, parity, hygienic practices, anaemia experience during pregnancy and household characteristics. Univariate linear regression was used to assess independent associations between variables that might predict haemoglobin levels. Correlation coefficients and variance inflation factor was used to check for multicolliniarity before running multivariate models for variables that were significantly associated with haemoglobin levels in univariate linear regression. Statistical analysis was conducted using IBM SPSS version 24. Statistical significance was considered when p-value was less than 0.05.

4.4 Results

4.4.1 Baseline characteristics of study participants

There were 438 participants during the 2018 follow-up survey. Majority of the children aged four and half years old while their mothers' mean age (SD) was 29.9 (6.2) years. The proportion of male to female children was almost the same. Most of the women were either unemployed or casual labourers and reported to have schooled up to elementary level. The proportion of wasted, underweight and overweight children was less than five percent while 12.6% were stunted (Table 4.1).

4.4.2 Food consumption frequency of the children

A well-balanced adequate diet was lacking as the majority of the children reported to consume cereals such as maize (ugali) and root crops such as potatoes as their staple food. Dark green vegetables, mostly kales were also popular while a smaller proportion of the children often ate meat and meat products, eggs, fruits, legumes, among others as presented in (Table 4.2).

4.4.3 Child morbidity experience, immunization, and hygienic practices

Child common illnesses reported by the mother two weeks before the survey were fever, diarrhoea, and common cold. Most of the children had received all the recommended immunizations, vitamin A supplementation and had taken at least a tablet for intestinal worms, as reported by their mothers. However, few had received other supplements such as iron and other micronutrient supplements since they were born (Table 4.3).

Proper hygienic practices were inadequate among the study participants as most of the mothers did not wash their hands often when necessary, the majority disposed waste on the road, in drainages and/or trenches. Moreover, water and toilet facilities were scarce resources with most of the households reporting absence of toilet facilities and limited access to free and continuous water supply (Table 4.3).

4.4.4 Anaemia prevalence and determinants of haemoglobin levels

Child mean (SD) haemoglobin was10.7± 1.5 g/dL with 33.9% reporting mild anaemia, 24.7% moderate and 1.2% severe. The total anaemia prevalence was similar in both study groups (59.3% intervention vs 60.2% control), (Table 4.3). Ethnic group, non-anaemic mothers in the past 1 year, frequently taking coloured fruits and vegetables as well as meat and meat products, child received all the recommended immunizations, toilet facility was located less than five minutes' walk from the compound and child's average mid-upper arm circumference were significantly associated with increasing haemoglobin levels. However, absence of toilet facility in the household and paying to use the toilet facility were significantly associated with lower haemoglobin levels in both univariate and multivariate regression analysis (Table 4.4).

4.5 Discussion

This study evaluated the prevalence and determinants of anaemia in two urban slums of Nairobi in the context of nutrition education and counselling of women implemented from pregnancy to when the child turned one-year-old. A high prevalence of anaemia was observed in this study area which was above 40%, hence, a severe public health problem as classified by WHO [20]. The present findings are comparable to a previous study in Kenya which reported anaemia prevalence of 73.2% among preschool children attending a well-baby clinic in Kiambu county, which neighbours Nairobi [21]. Conversely, a lower prevalence (28%) of anaemia in an urban slum of Nairobi was reported in another recent study which compared anaemia prevalence in both urban and rural Kenya. However, children in this study were aged between 6-12 years old and were recruited from an elementary school that participated in a school meal program of the World Food Programme [22], limiting direct comparisons with this study. In another study conducted in the Kibera slums of Nairobi, the prevalence of anaemia was 42% among 2-14 years-old children who did not participate in a school feeding program [23].

The study group (intervention and control) was controlled in the final multivariate model, however, it was not a determinant for haemoglobin levels. Moreover, there was no difference in anaemia prevalence between the two study groups. This might have resulted from the fact that the counselling program was not designed to specifically address measures for reduction of anaemia prevalence, rather it prioritized on exclusive breastfeeding up to 6 months and proper complementary feeding [13]. Therefore, mothers in the intervention group received monthly information on how to feed their children on a balanced diet and maintaining good hygienic practices as highlighted in already published counselling schedule [14]. Moreover, the counselling effect may have been diluted by the long time lag (about five years) between the intervention period and data collection, the poor living standards common in urban slums such as poor sanitation, poverty, illiteracy, inadequate resources, and limited access to adequate nutrition due to food insecurity [24].

A similar study conducted in Brazil did not find an association between systematic dietary counselling of mothers during the first year after birth and reduction of anaemia incidence [25]. In addition, a recent study which tested the combined effect of improved infant and young child feeding with water, sanitation, and hygiene (WASH) in their intervention, did not find an association between WASH and anaemia reduction [11]. However, studies that combined dietary counselling with provision of complementary food supplements and food feeding programs in poor settings reported a significant reduction in anaemia prevalence [12,23].

The causes of anaemia are multifactorial and various studies have highlighted its major risk factors in low-income settings. These include: poor dietary practices and inadequate nutrient intake which may cause micronutrient deficiencies such as iron, folate, riboflavin, vitamin A, and B-12 [6]. Moreover, inherited red blood cell disorders, e.g. sickle cell anaemia, and infections such as malaria, intestinal parasites like hook worms and schistosomiasis, human immunodeficiency virus among others increase anaemia risk in the affected individual [26].

The findings from this study show that inadequate sanitation such as absence of toilet facility and paying to use a toilet facility were associated with lower haemoglobin levels. Some residents in urban slums who do not own a toilet/latrine resort to using a paper bag or plastic container as an alternative for toilet and dispose the faecal waste in the garbage/trenches while young children mostly defecate in the open space [27]. A study in Nepal reported a correlation between open defecation and anaemia prevalence [28]. Poor faecal waste management is associated with infectious diseases such as cholera, diarrhoea, typhoid, and intestinal parasites, which weaken the intestinal wall leading to reduced nutrient absorption, blood loss, and loss of nutrients [29]. However, this study did not assess the direct link between intestinal parasites and anaemia as stool samples were not collected. Interestingly, toilet facility located about five minutes' walk from the household was associated with increasing haemoglobin levels. This finding may be explained by poor sanitation and hygienic practices involving the use of the toilet facilities located within the household. Urban slums have inadequate water supply and poor toilet facilities which may limit proper use of the toilets and increase infections as already reported in another study [30].

Child nutritional status assessed by mid upper arm circumference (MUAC), maternal anaemia and less intake of iron-rich foods, coloured fruits and vegetables and immunization were also associated with haemoglobin levels. Similar studies have reported child nutritional status, particularly height-for-age Z-score < -2, wasting, underweight, and recent history of anaemic mother to be significantly associated with anaemia in preschool children [31,32]. In other studies, children who are anaemic reported lower body weight than those with normal haemoglobin levels owing to altered intestinal functions and anorexia caused by the deficiency, hence predicting poor child nutrition status [32]. However, poor nutrition status can also predict anaemia in children. Mother's anaemia experience may predict child's haemoglobin levels because the dietary practices of the mother and child are essentially similar as they share the same socio-economic status [33]. Inadequate iron, vitamin A, and Vitamin C intake from food are also well-known causes of anaemia among preschool children [12]. In addition, other studies have reported that children who are not fully immunized have poor immunity, hence contract illnesses that may limit their nutritional intake due to poor appetite which can reduce iron availability in the body [21].

4.5.1 Study strengths and limitations

To the best of our knowledge, this is the first study to report the prevalence and determinants of anaemia in the context of maternal nutrition education and counselling in urban slums of

Nairobi. The initial study and data collection for this study was well monitored, which increases the reliability of the data.

However, the study has a number of limitations. First, nutrition counselling messages were not specific in addressing iron deficiency anaemia, although mothers were counselled on proper complementary feeding and hygienic practices which cover some of the risk factors of iron deficiency anaemia. Moreover, data on anaemia prevalence were collected about five years after the intervention ended. Therefore, the immediate effect of the intervention on anaemia prevalence was not assessed as child haemoglobin levels were not collected during the intervention period. In addition, this study was conducted in urban slums characterized by challenges which might reduce the effectiveness of the intervention and this limits generalizability to the whole population. Lastly, a number of participants were lost to follow-up, hence, the anaemia prevalence of the children who could not be traced or who had migrated out of the study was not accounted for.

4.6 Conclusion

Urban informal setting environment influences child anaemia situation. Hence, maternal nutrition education and counselling provided during the prenatal and postnatal period did not

have an effect in reducing iron deficiency anaemia among this children, about five years after the intervention ended. This may be due to the time difference between implementation of the intervention and anaemia testing or minimal knowledge retention. Poor sanitation and hygienic practices, children's nutrition status, ethnicity, immunization status, inadequate intake of meats, coloured fruits, and vegetables increase the vulnerability of preschool children to anaemia and compromises the effectiveness of this intervention in areas where the burden of anaemia is high. Further studies are required with intervention on improved sanitation facilities and access to meats, fruits, and vegetables in urban slums. Besides, there’s a need for studies assessing the effect of nutrition education intervention soon after it’s completed while integrating measures to address the identified determinants.

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Table 4. 1 General characteristics of study participants

	Intervention n=218		Control n=220		
Variable	Mean or n	% or SD	Mean or n	% or SD	p-value
Child characteristics					
Child mean age (months)	55.7	5.22	55.4	5.3	0.512
Gestation age at birth (weeks)	38.4	3.0	38.7	4.2	0.652
Child birth weight (kg)	3.3	0.6	3.2	0.6	0.453
Male	126	57.8	102	46.4	
Female	92	42.2	118	53.6	0.011
Child's mean weight (kg)	16.7	1.8	16.4	1.7	0.073
Child's mean length (cm)	103.9	4.7	103.4	1.7	0.314
Underweight (WAZ < -2SD)	6	2.8	10	4.5	0.250
Overweight BAZ ≥ 2SD	12	5.5	3	1.3	0.030
Stunted (HAZ < -2SD)	30	13.9	24	11.1	0.226
Mother's characteristics					
Mean and age group	30.4	6.6	29.6	5.8	0.163
14-20	5	2.3	1	0.5	
21-30	116	53.2	131	59.5	0.135
31-50	97	44.5	88	40.0	
Education levels					
Elementary school	145	66.6	124	56.3	
Secondary school	66	30.3	84	38.2	0.055
College/university	7	3.1	12	5.5	
Marital status					
Married	157	72.0	180	81.8	0.067
Unmarried	61	28	40	18.2	
Religion					
Christian	192	88.0	210	95.4	
Muslim	23	10.6	17	3.2	0.081
Other	204	2.6	3	1.4	
Parity					
0-1 child	51	23.4	40	18.2	
2 children	66	30.3	82	37.3	0.213
3 or more	101	46.3	98	44.5	
Occupation					
Unemployed	85	39.0	86	39.1	
Casual labour	79	36.3	72	32.7	
Own business	46	21.1	50	22.7	0.532
Salaried	8	3.7	12	5.5	

Table 4. 2 Food frequency table of foods fed to the child

Food group (frequency per week)	**Intervention n=218**		**Control n=220**		p-value
	n	%	n	%	
Cereals like maize, rice					
≥ 5	156	71.6	155	70.5	
3-4	50	22.9	45	20.5	0.323
<2	12	5.5	20	9.1	
Tubers and roots					
≥ 5	26	11.9	37	16.8	
3-4	68	31.2	62	28.2	0.507
<2	124	56.9	121	59.0	
Dark green leafy vegetables					
≥ 5	139	63.8	144	65.5	
3-4	67	30.7	47	21.4	0.005
<2	12	5.5	29	13.1	
Vitamin A rich fruits and vegetables					
≥ 5	58	26.6	70	31.8	
3-4	59	27.1	58	26.4	0.462
<2	101	46.3	92	41.8	
Meat and meat products					
≥ 6	5	2.3	17	7.7	
3-5	28	12.8	20	9.2	0.025
1-2	158	72.5	164	74.5	
Never	27	12.4	19	8.6	
Milk and milk products					
≥ 6	45	20.6	47	25.9	
3-5	47	21.6	32	14.5	0.134
1-2	99	45.4	110	50.1	
Never	27	12.4	21	9.5	
Pulses/legumes					
≥ 6	12	5.5	20	9.1	
3-5	45	20.6	49	22.3	0.261
1-2	144	66.1	141	64.1	
Never	17	7.8	10	4.5	
Eggs					
≥ 5	3	1.4	8	3.6	
3-4	38	17.4	25	11.4	0.125
1-2	140	64.2	142	64.5	
Never	37	17.0	45	20.5	
Sweets and oils (frequency per week)					
≥ 5	131	21.1	141	23.6	
3-4	41	18.8	27	12.3	
<2	46	60.1	52	64.1	

Table 4. 3 Prevalence of anaemia, feeding characteristics, morbidity experience and hygienic practices

Variable	Intervention n=218		Control n=220		p-value
	Mean or n	% or SD	Mean or n	% or SD	
Prevalence of anaemia					
Non anaemic	89	40.7	88	39.8	
Mild (100-109 g/L)	71	32.5	77	35.2	0.896
Moderate (70-99 g/L)	57	26.0	51	23.4	
Severe (<70 g/L)	2	0.8	4	1.6	
Micronutrient supplements and immunization					
Iron	49	18.3	51	23.2	0.129
Vitamin A	194	89.0	203	92.3	0.255
Calcium	51	23.4	54	24.5	0.432
Micronutrient powders	45	20.6	41	18.6	0.342
Deworming (intestinal parasites)	205	94.0	204	92.7	0.360
Therapeutic food supplements	35	16.1	30	13.6	0.282
Fully immunized	216	99.1	217	98.6	0.504
Child morbidity experience, 2 weeks prior to the survey					
Fever	42	19.3	51	23.2	0.188
Diarrhoea	35	16.1	28	12.7	0.226
Cough/common cold/flue	67	30.7	61	27.7	0.163
Main source of water					
Buy from a water kiosk	128	58.7	135	61.4	
Piped water to the compound	40	18.3	18	8.2	
Communal public taps	46	21.2	53	24.0	0.043
Personal storage tanks	4	1.8	14	6.4	
Water from this source was unavailable in the past 2 weeks	179	82.1	186	84.5	0.289
Location and accessibility of toilet facility					
Within the compound	151	69.3	107	48.7	0.001
Outside the compound <5 minutes' walk	67	30.7	113	51.3	
Pay to use this toilet facility	77	35.3	188	53.6	0.001
Occasions the mother washes hands					
After visiting the toilet	10	4.6	16	7.3	0.162
After handling child's waste	123	56.7	132	60.3	0.253
Before preparing food	90	41.5	104	47.5	0.122
Before eating	78	35.9	61	27.9	0.044
Before feeding the child	172	79.3	155	70.8	0.026
Where the household mainly disposes waste					
Garbage dumping site/pit	22	10.1	34	15.5	
Garbage disposal services	73	33.5	105	47.7	0.001
Road, drainage, trench/ all over	123	56.4	81	36.8	

Table 4. 4 Linear regression of determinants of anaemia

Variable categories	Standardized Coefficients (β)	95% confidence interval	p value	Adjusted Standardized (β)	95% confidence interval	P value
Study group	0.003	-0.222, 0.237	0.947	0.031	2.043,8.306	0.617
Ethnic group	0.099	0.002,0.085	0.039	0.125	0.002,0.123	0.042
Non anaemic mother in the past 1 year	0.138	0.383,1.985	0.004	0.205	0.792,3.352	0.002
Child was fully immunized	0.134	0.161, 3.509	0.032	0.141	0.193,3.467	0.029
Frequency of eating meat and its products per weeks	0.156	0.117, 0.984	0.013	0.145	0.027,1.044	0.039
Frequency of eating coloured fruits and vegetables per week	0.117	-0.004, 0.161	0.063	0.131	0.008,0.168	0.030
Absence of toilet facility at home	-0.132	-1.237, -0.044	0.036	-0.149	-1.312,-0.141	0.015
Household pay to use toilet facility	-0.146	-0.796, -0.070	0.020	-0.143	-0.788,0.064	0.021
Toilet is located <5mins walk, outside the compound	0.152	0.060, 0.748	0.021	0.156	0.074,0.758	0.017
Child's mean MUAC	0.116	0.023, 0.234	0.017	0.158	0.057,0.397	0.009

CHAPTER FIVE: General Conclusion and Recommendations

The present study evaluated the mid-term effectiveness of providing personalized-home based nutrition education and counselling on birth outcomes, stunting and anaemia prevalence. The study findings show a significant reduction in the prevalence of low birth weight, preterm delivery and stunting among children whose mothers received nutrition education and counselling however, no influence on anaemia prevalence. The intervention success may be attributed to the intensity and timing of the counselling process, the personalized nature of delivering the intervention, contents of the intervention package and evidences from significant changes of known risk factors for poor health outcomes among the intervention group.

Moreover, various factors were recognized as determinants of child birth and nutrition outcomes in the context of this intervention in urban slums. In general, this include maternal, child, and environmental factors such as women of short stature; teenage women; women's antenatal care practices; underweight and overweight women, child's gender, gestational age at birth, birth weight, child responsive feeding, child's diet, hygiene and sanitation practices etc. This provides evidence that for success of nutrition education interventions, an emphasis should be laid on addressing the aforementioned modifiable underlying risk factors that may compromises the effectiveness of the interventions.

Women living in informal settlements have low socio-economic and education levels. In addition, they are more susceptible to other social determinants of health. Therefore, their illiteracy and lack of knowledge may enhance their receptiveness of nutrition education and counselling. Thus, creating more awareness on the importance of utilizing nutrition and health services provided at the clinic during antenatal and postnatal care, understanding what constitutes a healthy diet for them and their children, how to achieve a healthy diet using locally available cheap foods, and how to improve their child's nutrition and health outcomes. As a result, we recommend the ministry of health in partnership with other healthcare providers and stakeholders to implement weekly and monthly nutrition education and counselling in the Kenya's essential package for health under the community health strategy of urban slums. This can be achieved through recruiting and training more CHWs on MIYCN, supervising them and motivating them by monthly salary reimbursements and other incentives.

Even though the approach of personalized nutrition education and counselling is gaining traction, we further recommend more studies on ways to optimize maternal and child nutrition through other personalized nutrition-sensitive and nutrition specific interventions particularly to more vulnerable populations. Furthermore, policies should focus on both micro and macro levels interventions to gain more impact and should take into consideration the ecological setting of where the intervention is to be implemented.

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Appendices

Appendix 1. Assorted images of the study site during data collection

Appendix 2. Questionnaire for fifth follow-up

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Section A: Socio Economic and Demographic Characteristics

Background for Identification

Field worker's ID___________ Date of interview ______/___/2018 Village of residence ________

Household ID_________________ID of the room where household head sleeps____________________

Study Group ____________________ 1) Control 2) Intervention Mother's ID____________________

ID of the index child___________________ Sex __________ 1) Male 2) Female

Q1. HOUSEHOLD CHARACTERISTICS

I.D/N	Sex M=1 F=2	Age	Relationship to HH head -codes-	Education Level codes	Occupation -codes-	Religion -codes-	Marital status -codes-
1							
2							
3							

RHHH	Education	Occupation	Religion	Marital Status
1=Husband 2=Wife 3=Son 4=Daughter 5=Brother 6=Sister 7=Relative 8=House girl	1=College/University 2=Secondary 3=Primary 4=Lower class 9 = N/A (Preschool)	1=Salaried employee 2=Own business 3=Casual laborer 4=Urban agriculture 5=Student 6=Housewife 7=Unemployed 8=N/A (Preschool)	1=Christian 2=Muslim 3=Traditional 4=Others (Specify)	1=Married 2=Separated 3=Widowed 4=Single 5=Divorced 6=N/A

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Section B: Index Child Information

Q2 – 10 Feeding and Postnatal Care Practices of Children Aged 24-72 Months

Child's ID	Q2 Date of birth	Q3 Was the child born term (after 37 weeks) or before	Q4 Child current age in months	Q5 Where is your child At school=1 At home=2 Child is dead=3 (*indicate the age and cause of the child's death then end interview*)	Q6 Did your child exclusively BF for the first 6 months 1=Yes 2=No 98=Don't know	Q7 How old was the child when you stopped BF?	Q 8 Did you receive any information about how to feed your child and your own nutrition from a Community Health Worker? 1=Yes 2=No 98= Do not remember (*if no indicate who provided information)*

Q9 Child ever received any micronutrient supplements 1=Vitamin A 2=Iron 3=Calcium 4=Micronutrient powders 5=Others,(specify)	Q10 If yes how many doses	Q11 Has (name) received any drug for intestinal worms 1=Yes 2=No	Q612 Has (name) Ever received therapeutic food supplements for malnutrition such as plumpy nuts 1=Yes 2=No	Q 13 Did (name) receive all the recommended immunization schedules/vaccines (confirm from the child booklet) 1=Yes 2=No	Q14 If no which immunization schedule did the child skip 1=BCG 2=OPV 3=Measles 4=Rotavirus 5=Hepatitis B 6=Tetanus 7=Others

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Q15 Food Frequency Questionnaire for the Children

FOOD EATEN	No of days consumed in a week							After 2 weeks	Once a month	Never consumed
	1	2	3	4	5	6	7			
Tea/porridge										
Potatoes										
Chips										
Ugali/maize										
Chapatti										
Mandazi										
Bread										
Rice										
Green Bananas										
Cakes, Biscuits										
Beef, chicken,pork,liver										
Eggs										
Beans,peas,grams,lentils										
Milk										

Yoghurt										
Pumpkin										
Spinach										
Kales										
Cabbage										
Traditional vegetables										
Fruits										
Sodas and juices										
Oils and margarine,										

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Section C: Nutrition Assessment of Mother-Child Pair

Q 17– Q128 Anthropometry and Haemoglobin for Children

I.D No	Q17 Sex 1=M 2=F	Q18 Age Months	Q19 Birth Weight in (Kg)	Q20 Weight 1st reading (0.1Kg	Q21 Weight 2nd reading (0.1Kg)	Q 22 Mean Weight (0.1kg)	Q 23 MUAC in cm	Q24 Height 1st (0.1cm)	Q25 Height 2nd (0.1cm)	Q26 Mean Height (0.1cm)	Q 27 Hb in (g/dL	Q28 %Haematocrit

Q29-Q38 Health and Anthropometry Measurement for Mothers to the Index Child

Q29 Age (Years)	Q30 No of previous births (parity)	Q31 Have you given birth after the index child, if Yes how old is the baby 1=Yes 2=No	Q32 Did you exclusively breastfeed the baby 1=Yes 2=No, if NO indicate the age mother stopped EBF	Q33 Incidence of these diseases 1=Anaemia 2=Diabetes 3=High blood pressure 4=Others (specify)	Q 34 Weight at the end of intervention	Q35 Weight 1st reading (0.1Kg	Q36 Weight 2nd reading (0.1Kg)	Q 37 Mean Weight (0.1kg)	Q 38 Height in cm (0.1m)

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Q39 – Q42 Morbidity Experience Among Children

First Name	Q39 Has the child experienced or shown any sign of illness within the last 2 weeks? 1=Yes 2 =No	Q40 If Yes which disease did the child suffer from in the last 2wks 1=Diarrhoea 2= Serious ARI[1] 3= Febrile illness/suspected Malaria[2] 4= Vomiting 5=Anaemia or related symptoms	Q41 Other illnesses? Specify	Q42 Where did you seek healthcare assistance when child was sick? 1=No assistance sought 2=Own Medication 3-=Traditional healer 4=Private clinic/pharmacy 5=Public health facility 6=Pharmacy 7=other (Specify

1 ARI asked using the three signs: cough, rapid breathing and fever
2 Suspected malaria/acute febrile illness: the three signs to be looked for are periodic chills/shivering, fever, sweating and sometimes a coma

Morbidity for Children

Q43 What is the most common illness by rank in this village/community among children

1) Diarrhoea/Vomiting........... [ ] 2) Common cold/fevers.. [ ] 3. Malaria, [ ] 4 Others [ ]

Effects of Maternal Nutrition Education on Child Nutrition and Health Status in Nairobi's Korogocho and Viwandani Informal Settlements, Kenya

Q44-50 Household Food Security Questionnaire

I.D No	Q44 What is the main source of food for your family 1) Purchase raw from market 2) Purchase cooked from street vendors/kiosks 3) Own production 4) Discarded food from dumpsites or markets 5) Borrow/relief food 6) Others, specify	Q45 On average how many meals does your child eat per day	Q46 In the past 4 weeks, did you worry that your household would NOT have enough food? How often 1=Never 2=Rarely 3=Sometimes 4=Often	Q47 In the past 4 weeks, did your household member eat a limited variety of food due to lack of resources 1=Never 2=Rarely 3=Sometimes 4=Often	Q48 In the past 4 weeks, was there ever NO food of any kind to eat in your household because of lack of resources to get food? How often 1=Never 2=Rarely 3=Sometimes 4=Often	Q49 In the past 4 weeks, did you or any household member go to sleep at night hungry because there was not enough food? How often? 1=Never 2=Rarely 3=Sometimes 4=Often	Q50 In the past 4 weeks, did you or any household member go a whole day and night without eating anything because there was NO food 1=Never 2=Rarely 3=Sometimes 4=Often
Rarely-once or twice in the last 4 weeks Sometimes-Once or twice every week…. or 3-10 times in the last 4 weeks Often-More than twice a week in the last 4 weeks…more than 10 times in the last 4 weeks							

Q51-58 Household Hygiene Questionnaire

I.D No	Q51 What is the MAIN source of drinking water the members of your household 1) Piped water into dwelling 2) Tap water from water Kiosk 3) Piped water from elsewhere 4) Tanks 6) Hawkers 7)Well/river/other surface water 8)Others specify	Q52 Do you treat water in any way to make it safer to drink? If YES, how 1)Filter 2) Boil 3) Water guard 4) UV rays 5) Sieve 6) Others	Q53 Is there a toilet facility in or near the house? 1=Yes 2=No If yes, what type of facility 1=Own flush/pit 2=Shared flush/pit latrine 3=Flush trench 4=Toilet without pit/working flush 5=No facility, field, flying toilet/bush	Q54 Do you pay to use toilet facility 1=Yes 2=No	Q55 The last time your child passed stool, where did he/she defecate 1=Use Potty 2=Washable diapers 3=Disposable diapers 4=Went in the house 5=In the compound 6=Never	Q56 How often do you wash your hand using soap 1=Never 2=Rarely 3=Sometimes 4=Often 5=Always	Q57 At what time or after/before what activities do you wash your hands with soap 1=After visiting toilet 2=Before eating 3=Before feeding your child 4=After handling your child's waste 5=Others, specify	Q58 Where does your household MAINLY dispose off garbage/waste in the last 4 weeks 1=Garbage dump/pit 2=Garbage disposal services 3=Road/rail ways/river drainage/trench/all over 4=Burning 3=Others, specify

Source

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Supplementary materials

Table S1. Postnatal visiting schedule for community health workers in intervention group

Visit	Age of baby	What to do/check	Messages to be given and action
1	2 – 3 days	How mother and baby are doing is baby breastfeeding well? Did mother get vitamin A supplementation? Did child get polio and BCG vaccination?	• Counsel on exclusive breastfeeding • Positioning and attachment if mother having difficulty • Importance of hygiene for mother and baby • Keep cord clean and dry • Mother's diet during breastfeeding
2	7 days	Condition of baby and cord. Baby is now fully breastfeeding Mother's health and condition of breasts	• To continue exclusive breastfeeding • Keep cord clean and dry • Mother's hygiene and diet • If baby or mother unwell refer for care at health facility
3	14 days		• Give message on expressing breastmilk • Review message on child spacing
4	21 days		
5	1 month	Baby and mother's health	• How to maintain exclusive breastfeeding • Give mother message on expressing breastmilk • Importance of the six-week check-up for mother and baby • Immunization
6	2 months	Check mother baby book for immunization (Polio, Pentavalent, and Pneumococcal at 6, 10 & 14 weeks) and growth monitoring. Has mother started attending a family planning clinic?	• Counsel on how to combine work with exclusive breastfeeding • Show mother how to express and store breastmilk
7	3 months		
8	4 months		
9	5months		• Start discussing complementary feeding
10	5 & half months	Check immunization – if no missed doses; is baby growing well?	• Continue counselling on complementary feeding: the foods to give, food hygiene, frequency and amounts in the 6th month • Vitamin A supplementation

11	6 months	Is baby growing well? Baby due for vitamin A supplementation	• Encourage to continue breastfeeding on demand. Start small amounts of complementary feeds 2 times per day
12	7 months	Continue checking baby's growth and health Remind mother to take baby for measles immunization (9mo); vitamin A (12months)	• Continue breastfeeding on demand • Gradually increase amounts and frequency; give a variety to meet baby's needs for adequate growth
13	8 months		
14	9		
15	10		
16	11		
17	12		

Table S2. Postnatal visiting schedule for community health workers in intervention group

Visit	Age of baby	What to do/check	Messages to be given and action
1	2 – 3 days	How mother and baby are doing is baby breastfeeding well? Did mother get vitamin A supplementation? Did child get polio and BCG vaccination?	• Counsel on exclusive breastfeeding • Positioning and attachment if mother having difficulty • Importance of hygiene for mother and baby • Keep cord clean and dry • Mother's diet during breastfeeding
2	7 days	Condition of baby and cord. Baby is now fully breastfeeding Mother's health and condition of breasts	• To continue exclusive breastfeeding • Keep cord clean and dry • Mother's hygiene and diet • If baby or mother unwell refer for care at health facility
3	14 days		• Give message on expressing breastmilk • Review message on child spacing
4	21 days		
5	1 month	Baby and mother's health	• How to maintain exclusive breastfeeding • Give mother message on expressing breastmilk • Importance of the six-week check-up for mother and baby • Immunization
6	2 months	Check mother baby book for immunization (Polio, Pentavalent, and Pneumococcal at 6, 10 & 14 weeks) and growth monitoring. Has mother started attending a family planning clinic?	• Counsel on how to combine work with exclusive breastfeeding • Show mother how to express and store breastmilk
7	3 months		
8	4 months		
9	5months		• Start discussing complementary feeding
10	5 & half months	Check immunization – if no missed doses; is baby growing well?	• Continue counselling on complementary feeding: the foods to give, food hygiene, frequency and amounts in the 6^{th} month • Vitamin A supplementation

11	6 months	Is baby growing well? Baby due for vitamin A supplementation	• Encourage to continue breastfeeding on demand. Start small amounts of complementary feeds 2 times per day
12	7 months	Continue checking baby's growth and health Remind mother to take baby for measles immunization (9mo); vitamin A (12months)	• Continue breastfeeding on demand • Gradually increase amounts and frequency; give a variety to meet baby's needs for adequate growth
13	8 months		
14	9		
15	10		
16	11		
17	12		

Table S2. Postnatal visiting schedule for community health workers in intervention group

Visit	Age of baby	What to do/check	Messages to be given and action
1	2 – 3 days	How mother and baby are doing is baby breastfeeding well? Did mother get vitamin A supplementation? Did child get polio and BCG vaccination?	• Counsel on exclusive breastfeeding • Positioning and attachment if mother having difficulty • Importance of hygiene for mother and baby • Keep cord clean and dry • Mother's diet during breastfeeding
2	7 days	Condition of baby and cord. Baby is now fully breastfeeding Mother's health and condition of breasts	• To continue exclusive breastfeeding • Keep cord clean and dry • Mother's hygiene and diet • If baby or mother unwell refer for care at health facility
3	14 days		• Give message on expressing breastmilk • Review message on child spacing
4	21 days		
5	1 month	Baby and mother's health	• How to maintain exclusive breastfeeding • Give mother message on expressing breastmilk • Importance of the six-week check-up for mother and baby • Immunization
6	2 months	Check mother baby book for immunization (Polio, Pentavalent, and Pneumococcal at 6, 10 & 14 weeks) and growth monitoring. Has mother started attending a family planning clinic?	• Counsel on how to combine work with exclusive breastfeeding • Show mother how to express and store breastmilk
7	3 months		
8	4 months		
9	5months		• Start discussing complementary feeding
10	5 & half months	Check immunization – if no missed doses; is baby growing well?	• Continue counselling on complementary feeding: the foods to give, food hygiene, frequency and amounts in the 6th month • Vitamin A supplementation

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