Measuring Nutrition:
Comparing different nutritional assessment tools and analyzing intra-household inequality in rural Kenya.

Dissertation

to obtain the Ph.D. degree

in the International Ph.D. Program for Agricultural Sciences in Goettingen (IPAG)

at the Faculty of Agricultural Sciences,

Georg-August-University Goettingen, Germany

presented by

Andrea Fongar

born in Königstein i.T., Germany

Goettingen, March 2018

D7

1st Supervisor: Prof. Dr. Matin Qaim

2nd Supervisor: Prof. Dr. Meike Wollni

3rd Supervisor: Prof. Dr. Claudia Neu

Date of dissertation: 17th of May 2018

Summary

Good and improved nutrition is an essential driver of human development, a platform for progress in health and equality. But in spite of notable improvements in achieving global nutrition goals, the malnutrition and food security situation has worsened, especially in Sub-Saharan Africa. Underweight, micronutrient deficiencies and overweight/obesity are contributing factors to the multiple burdens of malnutrition globally. Worldwide, more than 800 million people remain undernourished and 2 billion people suffer from micronutrient deficiencies, caused by imbalanced diets. Stunted growth affects one out of four children, and 52 million children under the age of five are affected by acute malnutrition. At the same time, the global nutrition landscape recognizes a significant upward trend in the prevalence of overweight and obesity of adults, and children.

Especially, low- and middle-income countries experience high rates of underweight, micronutrient deficiencies and overweight or obesity. Malnutrition affects one in three people directly and many even suffer from several deficiencies simultaneously. Kenya in particular, reports a substantial increase in overweight and obesity rates, while levels of undernutrition remain high. Moreover, intra-household inequality of malnutrition describes a situation where family members face different nutritional deficiencies within the same household.

The identification of poor diets is especially important, as poor diets are one contributor to the global burden of malnutrition and an indicator of food insecurity. Therefore, it is important and necessary to keenly assess how nutrition is measured. Against this background, this dissertation presents two essays dealing with nutrition measurements. In the first essay, we investigate the association of results from different nutritional assessment tools for the same households and individuals. In the second essay, we identify different ways to define the double burden of malnutrition at household and individual level in rural Kenya.

To measure nutrition, a wide set of assessment methods and indicators exist. Various tools measure and describe malnutrition and food insecurity, ranging from various food production and consumption based indicators up to anthropometric measurements and individual health outcomes. Each of the tools has a somewhat different focus and interpretation, but with the common aim to measure how well people are nourished. A positive correlation between the different indicators would be expected, but is that really true? Empirical evidence is limited, as many existing studies eventually rely on one approach, or a small set of indicators to display

food and nutrition security and malnutrition. Therefore, relatively little is known about how closely results match when different assessment tools are used in the same context.

The first essay of this dissertation directly addressed this question by comparing results from different assessment tools for the same households and individuals. The applied assessment tools build on seven-day food consumption and 24-hour dietary recalls at household and individual level. Individual height and weight measures were also taken. Different indicators of food access (energy consumption, household dietary diversity scores), dietary quality (individual dietary diversity scores, micronutrient intakes), and nutrition (anthropometric indicators) were calculated and correlated to evaluate their associations with data collected from 809 households and 1,556 individuals living in these households (female and male adults, and children aged 6-59 months). We found out that all measures of food access and dietary quality are positively correlated at the individual level. Household level and individual level dietary indicators are also positively correlated. However, correlations between the dietary indicators and the anthropometric measures are very small and mostly statistically insignificant. We conclude that dietary indicators from seven-day food consumption recall at the household level can be used as proxies for individual dietary quality of children, male and female adults.

The second essay deals with issues of nutritional inequality. Malnutrition is mostly assessed and calculated with anthropometric measurements. Through certain cut-off points and categorization schemes underweight, stunting, wasting, overweight and obesity are classified. Multiple forms of malnutrition coexist in various forms. The occurrence of undernutrition along with overweight in the same setting is often referred to as the double burden of malnutrition. Undernutrition, within the double burden of malnutrition definition, can be described as underweight, stunting, wasting or micronutrient deficiency. The phenomenon can occur at different levels; population level, household level and individual level. Coexistence of underweight, micronutrient deficiency along with overweight/obesity increases steadily in its prevalence, particularly in low- and middle-income countries. Indicators to define undernutrition within the double burden of malnutrition definition differ within articles, which make comparison difficult.

In the second essay, we analyze the double burden of malnutrition within households and individuals (male and female adults, and children <5 years) in rural Kenya. We identify and apply seven different double burden definitions to cross-sectional data. The first two double burden definitions show the coexistence of overweight/obesity and micronutrient deficiency of adults and children. Definitions three to seven are defined as an overweight/obese adult and an underweight, stunted, wasted or micronutrient deficient child. A total of 874 adults, 184 children, and 173 households were used in the calculations. We found out that micronutrient deficiency and overweight/obesity simultaneously occur in 19% of the adults and 10% of the children. Double burden at household level is also observed for all applied definitions. However, the magnitude of the double burden problem depends much on the particular definition used, so comparisons across different surveys and definitions have to be done with caution.

Acknowledgements

"*Life is an awfully big adventure*" (Peter Pan).

One adventure ends, another one is about to start. But before the new one starts, I want to have a quick look back over the adventure of the last three years. First of all, I want to express my gratitude to my supervisor Prof. Qaim for the opportunity and trust to start this adventure to begin with. I am very thankful for your advice and guidance, for keeping me on track and focused. I can say that I have learned a lot within those three years. Furthermore, I want to thank Meike for being my second supervisor, discussing my paper ideas and being part of the ADDA (Agriculture and Dietary Diversity in Africa) team, it was very nice working with you. Many thanks, also to Theda. Thanks for being with me on this adventure.

Not to forget in this place, I also want to thank ADDA for the opportunity of this adventure and in this line I want to extent my thanks to the whole team, my colleagues from the University of Göttingen, from the University of Nairobi and from Africa Harvest. Thanks for the endless discussion, cooperation and assistance during the field work and the inspiring team experience. In this regard, I also want to thank the rest of the extended ADDA team, our student assistants, enumerators and drivers, without them our data collection would not have been possible. Thank you so much for your contribution of knowledge, time and the team spirit. This research was financially supported by the German Federal Ministry of Food and Agriculture (BMEL), grant number 2813FSNu01. Thank you for the support.

Göttingen has been for me not only a scientific adventure but also a personal one, which was enrichened by the beauty of my running-group, the GlobalFood and chair family. Thanks for taking me in and making the last three years amazing. I could list names at this place, but those of you who made this journey so adventurous, sportive and unforgettable know it, and there will ever be a place in my heart for you. However, there are a couple of names I do want to mention.

Lisa, without you the story would have been definitely different and I am not even sure if I would have finished it. I do not even know where to begin with, as there are so many things flying around in my head I want to say to you. Thanks for being at my side and watching my back, not only as my office and ADDA mate, but as a good friend. Thanks for being with me on this adventure, and going through all the phases of it.

There are two special friends without whom I would not have even started this adventure to begin with. Maggy, thank you so much for being my friend, believing in me and inspiring me. Sometimes, I still think about how this adventure would have been if our plan would have worked out. Kathrin, thanks for showing me what I can achieve, for pointing out things that I never thought of, for your encouragement and guidance.

Sören and the whole gang, thanks for bearing and staying with me for so many years and whichever adventure I go on. Because of you guys, I know that there are always so many more important things in life. Thanks guys for your honest friendship, for cheering me up, and for our wonderful trips.

I owe gratitude to my family and parents, for their never ending support. You are my earth in life. Because of you I am where I am today, you always managed that I keep going, to believe in myself and that anything is possible if I worked hard. One of the biggest thanks goes to my sister, my closest friend. Thank you so much for your love, our scientific and non-scientific discussions, for bringing back perspective and your creativity, which sweeten up my day. Torben, you became part of an even bigger adventure, my life. Thank you for being part of it, for your never ending optimism, for keeping up with me and your endless surprises.

Table of contents

List of abbreviations

µg	Microgram
ADDA	Agriculture and Dietary Diversity in Africa
AE	Adult equivalent
Africa Harvest	Africa Harvest Biotech Foundation International
BAZ	Body mass index-for-age Z-score
BMI	Body mass index
d	Day
DB	Double burden of malnutrition
DD	Dietary diversity
DDS	Dietary diversity score
Def	Deficiency
DHS	Demographic and Health Survey
DR	Dietary recall
EAR	Estimated average requirement
F/V	Fruit and vegetables
FAO	Food and Agriculture Organization of the United Nations
FCR	Food consumption recall
FG	Food group
FHI	Family Health International
FS	Food security
FVS	Food variety score
g	Gram
h	Hour
HAZ	Height-for-age Z-score
HDDS	Household dietary diversity score
HH	Household
ht	height
IFPRI	International Food Policy Research Institute
IOM	Institute of Medicine
IQR	Interquartile range
Kcal	Kilocalorie

kj	Kilojoule
KNBS	Kenya National Bureau of Statistics
Ksh	Kenyan Shilling
MDD	Minimum dietary diversity
MDD-W	Minimum dietary diversity for women of reproductive age
mg	Milligram
n	Sample size
NCD	Non-communicable diseases
SD	Standard deviation
UNICEF	United Nations Children's Fund
USAD	United States Department of Agriculture
VA	Vitamin A
WAZ	Weight-for-age Z-score
WHO	World Health Organization
WHZ	Weight-for-height Z-score
wt	Weight
y	Year

List of tables

List of figures

1 General introduction

1.1 Background

"A better nourished world is a better world" (Development Initiatives, 2017, p. 9). Good and improved nutrition is an essential driver of human development, a platform for progress in health and equality, a help to break the cycle of poverty, as well as a foundation for peaceful, secure and stable societies. But in spite of notable improvements in achieving global food and nutrition security, "*the world* still *faces a grave nutrition situation*" (Development Initiatives, 2017, p. 9). Food security and hunger situations worsened in many parts of the world, and malnutrition and poor diets are by far the biggest threat to the global burden of diseases (Development Initiatives, 2017; FAO et al., 2017; IFPRI, 2016, 2015).

Malnutrition manifests itself in many different ways. Underweight, micronutrient deficiency and overweight/obesity are contributing factors to the multiple burdens of malnutrition, which affects one out of three people directly and many even suffer from several deficiencies simultaneously (FAO et al., 2017; IFPRI, 2017). More than 800 million people remain undernourished, and one out of four children under the age of five years is too short for their age, with increasing numbers especially in Africa (FAO et al., 2017; IFPRI, 2017). Worldwide, 2 billion people suffer from imbalanced diets and are affected by micronutrient deficiency (Development Initiatives, 2017). At the same time, the world faces an escalating problem of overweight and obesity, where an immense upward trend of the prevalence of adults and children has been recognized (Development Initiatives, 2017; FAO et al., 2017; IFPRI, 2017).

Many low- and middle-income countries face multiple burdens of malnutrition, meaning that they are simultaneously experiencing high rates of undernutrition, micronutrient malnutrition, overweight/obesity and nutrition-related non-communicable diseases (NCDs). In Kenya, for example, levels of undernutrition remained high over the last decades, while overweight and obesity rates increased steadily (KNBS, 2015; Masibo and Makoka, 2012). Not only countries face multiple burdens, also households and individuals are affected by the inequality of malnutrition. Causes of malnutrition are complex and multidimensional. One leading factor in the occurrence of multiple burdens has been the nutrition transition phenomenon, which is characterized by changes in diet and lifestyle patterns. Countries face a shift from traditional diets towards more energy-dense and ready-to-eat food items, combined with more sedentary

occupations that lead to physical inactivity. The identification of poor diets is especially important, as poor diets are one contributor to the global burden of diseases and linked to abnormal nutritional status. Simultaneous to nutrition transition, demographic and epidemiological transitions contribute to inequality of malnutrition and affect intra-household and intra-individual problems (Drewnoski, 2017; FAO et al., 2017; Popkin et al., 2012; WHO, 2017). Therefore, good nutrition is not only important to achieve the full potential of individual human beings, but also a signal of the realization of people's right to food and health, and therefore narrowing the inequality in our world (Development Initiatives, 2017; FAO et al., 2015; IFPRI, 2015; WHO, 2017).

Those examples illustrate the complexity of fighting hunger and to combat malnutrition. To reduce inequality and achieve high quality nutrition for all, nutrition needs to be measured. Moreover, causes of the nutritional situation and its inequality need to be identified in order to define the starting points for substantial improvements. The worldwide nutritional situation depicts the necessity and importance of keenly assessing how to measure nutrition. Measurements of nutrition are important to reveal and monitor food security, hunger and malnutrition. However, many different kinds of nutrition measurements are performed and the question remains how results of various indicators compare? Do different indicators lead to the same conclusion and can they be used as a proxy for missing links?

Multiple indicators to measure and describe nutrition exist, varying from food production and consumption based indicators up to anthropometric measurements and individual health outcomes. Food consumption is often measured to reveal food availability, access and affordability to display food security, which is a concept mostly used at the household level. At the same time, food consumption can also be estimated at the individual level, to provide information about nutrition security. Assessments at individual level depict dietary quality and can reveal insufficient intake of essential macro- and micronutrients. Thus, measuring adequate diets, micronutrient deficiencies, food and nutrition security is very important, as a low quality diet is a contributing factor and underlying cause of different forms of malnutrition (Development Initiatives, 2017; Drewnoski, 2017; Dwyer and Drewnoski, 2017). The various concepts of food and nutrition security use many different, but somewhat similar tools to assess and measure undernourishment. Differences mostly depend on the scope of the research.

Imbalanced intake of inadequate or excessive energy leads to malnutrition in form of wasting, stunting, underweight, as well as overweight and obesity. Those indicators are commonly used to describe the nutritional situation of an individual and are another way to measure nutrition. Growth assessments are done via the use of anthropometric measures. More precisely, anthropometric indicators are used to depict the nutritional status of individuals. Nutritional status of adults is indicated by the body mass index (BMI), which is defined as the weight in kilograms divided by the square height of a person (kg/m^2). The BMI indicator was developed to indicate the risk of diseases and differentiates between underweight, overweight and obesity of adults (WHO, 2018a, 2006). Growth assessments of children evaluate the nutritional status of children and provide an indirect measure of the quality of life. Child growth information is an important, recognized indicator of public health. Weight, height and age measures are used to calculate different growth indicators of children and adolescents. Low height-for-age describes a condition of chronic absence of adequate food and results in growth retardation, which is often called stunted growth. Low weight-for-height indicates wasting in children, resulting from acute starvation or severe disease. Overweight of children is on the other hand described as high weight-for-height and body mass index-for-age. Low weight-for-age and body mass index-for age are also used to describe underweight problems (de Onis and Blössner, 2003; WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006; WHO and UNICEF, 2009).

Anthropometric indicators and dietary assessments represent two widely used methods to measure nutrition. Other measurements do exist, but the two named concepts are the ones most commonly used in developing countries to display inequality of malnutrition. However, within those concepts various indicators exist, which makes monitoring of the nutritional situation difficult. It is important to understand each indicator itself plus its relationship to the other indicators, in order to monitor progress towards the achievement of the global nutrition targets to eradicate malnutrition, hunger and food insecurity (Carletto et al., 2013; Development Initiatives, 2017).

1.2 Problem statement

Food consumption assessments and anthropometric indicators are commonly used methods to measure nutrition, but they differ in the way they are applied and interpreted.

Several papers and international reports deal with the assessment of food consumption data to monitor the well-being of any human population. Household food consumption data is widely

collected by various disciplines and therefore interpreted in different ways. For example, food security analysts are interested in the availability of food, economists focus on the amount of money spent on food and nutritionist are interested in the actual quantities of consumption of food (Zezza et al., 2017). Quantities of different consumed food items can be converted into energy and particular nutrient intakes and set in relation to recommended levels to derive adequacy ratios (FAO, 2004). Yet, nutrition is an important individual outcome, especially to monitor intra-household inequality, and therefore often measured at the individual level. As alternative approaches to food consumption and dietary assessments, measures of food variety and dietary diversity can be calculated at household and individual level. These alternative measures can be applied if only frequencies of consumed food items are known, rather than exact quantities (Carletto et al., 2013; Habte and Krawinkel, 2016). Both diversity measures are used to display the variety of different food items consumed, and are classified by the number of different foods or food groups consumed. The interpretation varies much between applied food groups and those for whom it was collected (Ruel et al., 2013). Not only can food security and dietary quality be assessed at different levels - household and individual - food consumption data can also be collected with different tools. Most commonly, food recall methods are used with variations in the recall period (de Haen et al., 2011). Seven-day or 30-day food consumption recalls (FCR) and 24-hour dietary recalls (DR) are typical tools (Coates et al., 2017; Zezza et al., 2017).

Various indicators to describe food and nutrition insecurity exist, ranging from various food production to the consumption based indicators. Each of them has a somewhat different focus and interpretation, but with the common aim to measure how well people are nourished. Positive correlations between the different indicators would be expected, however empirical evidence is limited, as many existing studies only use one indicator, or a small set of indicators to display food and nutrition security and malnutrition. Therefore, little is known about how closely results match.

Multiple forms of malnutrition exist, displaying the complexity and inequality of malnutrition that regions, nations and the world is facing. Especially, low- and middle-income countries experience high rates of underweight, micronutrient deficiencies and overweight or obesity. Moreover, intra-household inequality of malnutrition describes a situation where family members face different nutritional deficiencies within the same household. The occurrence of undernutrition along with overweight is often referred to as the double burden of malnutrition

(DB) (WHO, 2018c, 2017). The manifestation of DB can occur at three different levels. It is observed at population level with undernutrition and overweight and obesity within the same community, region or nation. At household level, DB refers to the coexistence of an overweight/obese member and an undernourished member. Moreover, DB at individual level describes the occurrence of simultaneous developments of two or more types of malnutrition, overweight/obesity along with nutritional deficiencies. Undernutrition is described in the DB literature in two different ways, either as underweight or micronutrient deficiency (WHO, 2018c, 2017).

Various combinations of DB have been studied. Empirical evidence of the existence of DB as the coexistence of an underweight and overweight member was shown for different countries and households in Brazil, China, the Kyrgyz Republic, Russia, Vietnam, the United States, and Indonesia (Doak et al., 2005; Hanandita and Tampubolon, 2015; Roemling and Qaim, 2013). Special interest of research was shown to the existence of DB for mothers and child pairs, which has been identified in Malaysia, Indonesia, urban Kenya and within three multi-country surveys using Demographic and Health (DHS) and World Health Organization data (Dieffenbach and Stein, 2012; Garrett and Ruel, 2005; Ihab et al., 2013; Jehn and Brewis, 2009; Kimani-Murage et al., 2015; Saibul et al., 2009; Wibowo et al., 2015; Wojcicki, 2014). Literature that uses micronutrient deficiency as an indicator for undernutrition, is relatively rare and mostly of interest within children, adolescence and women of reproductive age (Freire et al., 2014; Jones et al., 2016; Laillou et al., 2014). Moreover, micronutrient deficiency and overweight can also occur within one household. Evidence of this particular DB definition was only shown by Freire et al. (2014) in Latin America.

In spite of this evidence, the measures applied to display the different components of DB, differ between studies. Classification of underweight and overweight/obesity of adults is straightforward and uniform in using the BMI and categorization proposed by WHO (WHO, 2018a, 2006). The classification of undernutrition of children on the other hand differs in the use of different Z-score indicators. Indicators used are weight-for-age Z-scores (WAZ) (Ihab et al., 2013; Saibul et al., 2009), height-for-age Z-scores (HAZ) (Dieffenbach and Stein, 2012; Garrett and Ruel, 2005; Kimani-Murage et al., 2015), BMI-for-age Z-score (BAZ) (Roemling and Qaim, 2013), adult BMI classification (Doak et al., 2005) or combinations of WAZ and HAZ or WAZ/HAZ and weight-for-height Z-score (WHZ) (Jehn and Brewis, 2009; Wibowo et al., 2015).

This dissertation includes two essays, which deal with the assessments of nutrition. The first essay directly addresses the question if household level and individual level indicators of food access, dietary quality and nutrition relate. The second essay analyzes different definitions of DB at household and individual level. Both essays build on cross-section data collection in rural Kenya in 2015 and 2016.

1.3 Research objectives and approach

This dissertation is composed of two essays, which focus on measuring nutrition within the scope of the aforementioned problem statements. Data used for both papers were collected through a comprehensive household survey in rural Kenya.

Specifically, the first essay analyzes the relationship between different nutrition assessment tools and contributes to the literature by comparing a larger set of nutritional indicators at household and individual levels. A 7d FCR and 24h DR were administered at household and individual level, respectively. Individual height and weight measures were taken from male and female adults and children aged 6-59 months. Different indicators of food access (energy consumption, household dietary diversity scores), dietary quality (individual dietary diversity scores, micronutrient intakes), and nutritionals status (anthropometric indicators) were calculated and correlated to evaluate their associations.

The objective of the second essay is to identify the nature of the DB with different measures of undernutrition and at different levels. First, the prevalence of DB was assessed at individual level, in male and female adults, and children <5 years, using micronutrient deficiency as indicators of undernutrition. Second, we identified DB at household level, using different measures of undernutrition (underweight, stunting, wasting and micronutrient deficiency). Since differentiated measures of undernutrition for the assessment of DB are scarce and never were combined in one study, we provide novel insights. A further novelty of this study is the analysis of DB in rural areas, which was only analyzed in urban areas so far.

1.3.1 Data

Data used in both essays were collected through a comprehensive household-survey, which was embedded in the large interdisciplinary project *'Agriculture and Dietary Diversity in Africa'*, in short called ADDA. The project consisted of a team of researchers (including the author) from the University of Goettingen and University of Nairobi, who were responsible for the project design and data collection. The partner Africa Harvest Biotech Foundation International (Africa Harvest) facilitated the access to the region and the farmer groups.

Figure 1.1 shows a map of Kenya with the two purposively selected counties, namely Kisii and Nyamira County, in the Nyanza region, which is located in West Kenya. Households in this region are involved in subsistence-oriented farming activities and face relatively high malnutrition rates (KNBS, 2015; Masibo and Makoka, 2012; Mbuvi et al., 2013). According to official statistics, 23% of children below the age of five are stunted and 7% were wasted in the Nyanza region. At the same time, 4% of children <5 years are obese (weight-for-height Z-score >+2 SD), and almost 30% of females aged 15-49 years are classified as overweight and obese in the region (KNBS, 2015).

Selection of households for the survey builds on a two-stage random sampling strategy. First, 48 farmer groups were randomly sampled proportional to the total number of groups existing per county (32 Kisii and 16 Nyamira). Second, around 20 households from each group were randomly sampled based on existing and updated membership lists. The household survey was implemented in two rounds. The first survey was carried out between October and December 2015, the second round exactly twelve months later, in 2016. In total, 835 households were surveyed in 2015 using structured, face-to-face interviews (see *General appendix*: household questionnaire 2015/2016). In 2016, 764 households were revisited. Additional to the household level information, three individuals in the sampled households were targeted. A male adult, a female adult and a child aged 6-59 months were targeted to obtain individual food intake data, nutrition knowledge data and anthropometric measurements. Further details on the study design and the methodological approach can be found in the Chapter 2.2.2 and Chapter 3.2.1.

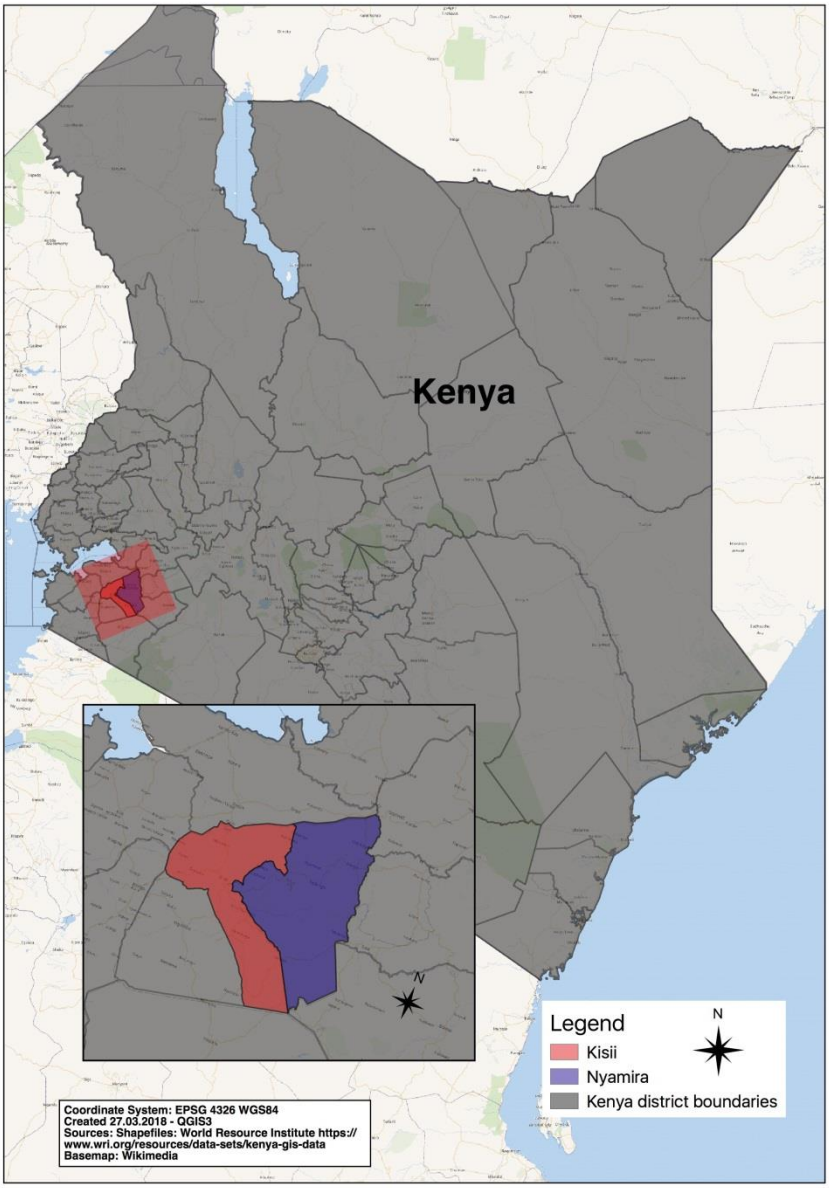

Figure 1.1 Map of Kenya with the study sites Kisii and Nyamira County.

The outline of this dissertation is structured as follows: Chapter 2 presents the first paper, comparing nutritional indicators at household and individual level. In Chapter 3, the second paper is presented. It identifies and analyses the nature of double burden. Chapter 4 draws broader conclusions, followed by the References and the General appendix.

2 How well do different nutrition assessment tools match? Insights from rural Kenya[1]

Abstract

Various indicators and assessment tools exist to measure nutrition. Most studies eventually rely on one approach. Relatively little is known about how closely results match when different assessment tools are used in the same context. This study contributes to the literature by comparing results from different assessment tools for the same households and individuals. A cross-section survey of households and individuals was carried out in rural farm households in two counties in Western Kenya in 2015. Seven-day food consumption and 24-hour dietary recalls were administered at household and individual level, respectively. Individual height and weight measures were taken. Different indicators of food access (energy consumption, household dietary diversity scores), dietary quality (individual dietary diversity scores, micronutrient intakes), and nutrition (anthropometric indicators) were calculated and correlated to evaluate their associations. Data were collected from 809 households and 1,556 individuals living in these households (782 female adults, 479 male adults, 295 children aged 6-59 months). All measures of food access and dietary quality are positively correlated at individual level. Household level and individual level dietary indicators are also positively correlated. However, correlations between the dietary indicators and the anthropometric measures are very small and mostly statistically insignificant. Dietary indicators from 7-day food consumption recalls at the household level can be used as proxies of individual dietary quality of children and male and female adults. Individual dietary diversity scores are good proxies of micronutrient intakes. However, neither household level nor individual level dietary indicators are good proxies of individual nutrition status in this setting.

Keywords*:* Dietary diversity, dietary quality, nutritional assessment, household data, individual data

[1] This chapter is co-authored by Theda Gödecke, Antony Aseta, and Matin Qaim. The authors contributions are as follows: All authors contributed to the design of the research. I (AF) collected the data, analysed the data and wrote the manuscript. All authors commented and approved the final version of the paper.

2.1 Introduction

In spite of notable improvements in achieving global food security, more than 800 million people remain undernourished (FAO et al., 2017). One out of three individuals worldwide is affected by at least one form of nutritional deficiency; many suffer from several deficiencies simultaneously. Micronutrient malnutrition remains one of the largest nutritional problems worldwide (Steyn et al., 2006). Multiple indicators to measure and describe malnutrition and food insecurity exist, ranging from various food production and consumption based indicators up to anthropometric measurements and individual health outcomes (Carletto et al., 2013; Chávez Zander, 2014; FAO and FHI 360, 2016; Habte and Krawinkel, 2016; Hoddinott and Yohannes, 2002; Kant, 1996; Keding et al., 2012; Kennedy et al., 2010; Nelson et al., 2004; Ruel, 2003; Ruel et al., 2013; Swindale and Bilinsky, 2006; WHO et al., 2008, 2010; WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006; WHO and UNICEF, 2009). Each of the indicators has a somewhat different focus and interpretation, but eventually all of them are used to measure how well people are nourished. Hence, a positive correlation between the different indicators would be expected. But is this really true? Answering this question would be important in order to understand whether certain indicators can be used as proxies for others for which data may not easily be available in certain situations. For instance, can household level food consumption indicators be used as proxies for individual level dietary quality or nutrition status? Empirical evidence to answer such questions is limited. Many existing studies only use one indicator, or a small set of indicators, without comparing them to many others. Comparisons between household level and individual level indicators are particularly rare. We contribute to the literature on the measurements of diets and nutrition by comparing a larger set of indicators for the same study population.

The best measures of nutritional status are anthropometric indicators based on individual weight and height data (Nelson et al., 2004). Common anthropometric indicators that are used to measure nutritional status are the body mass index (BMI) for adults, or height-for-age and weight-for-age Z-scores for children (WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006; WHO and UNICEF, 2009). However, these anthropometric indicators are not necessarily good proxies of food security and dietary quality, as factors other than food intake can also influence body height and weight.

Food security and dietary quality are better measured through food consumption data that can be collected at household or individual level. If data on the quantity of different food items consumed are available, it is possible to calculate the intake of energy and particular nutrients and set these amounts in relation to recommended levels to derive adequacy ratios (FAO, 2004). Alternatively, measures of food variety or of dietary diversity can be calculated, which is possible also when the frequency but not the quantity of food items consumed is known (Carletto et al., 2013; Habte and Krawinkel, 2016). The food variety score (FVS) is a simple count of the number of food items consumed over a certain period of time and thus measures the variety of dietary intake (Chávez Zander, 2014; Keding et al., 2012; Ruel, 2003). Dietary diversity (DD) scores count the number of food groups (FG) consumed (Kant, 1996; Ruel, 2003; Ruel et al., 2013). Different DD scores with variations in the FG classifications exist (Ruel et al., 2013). Household level DD scores are considered good and simple indicators of access to food and food security (FAO and FHI 360, 2016; Kennedy et al., 2010; Swindale and Bilinsky, 2006). Depending on the FG classification, individual level DD scores are better indicators of dietary quality (FAO and FHI 360, 2016). Specific DD scores were developed for women and children, as these are often the most vulnerable population groups (FAO and FHI 360, 2016; WHO et al., 2010, 2008).

Food consumption data can be collected with different methods. Most commonly, food recall methods are used, with variations in the recall period (de Haen et al., 2011). Seven-day or 30-day food consumption recalls (FCR) and 24-hour dietary recalls (DR) are typical tools (Coates et al., 2017; Zezza et al., 2017). At the household level, 7d FCR is frequently used to calculate measures of energy and nutrient consumption. However, such consumption indicators do not measure actual food intake, as issues of food waste, intra-household distribution, and food away from home are not considered (de Haen et al., 2011; Koppmair et al., 2017). Actual food intake is better captured through 24h DR at the individual level, which can also take into account food preparation methods and food consumed away from home.

Several studies have analyzed the relationships of different indicators either at household or at individual level. For instance, Hoddinott and Yohannes (2002) examined the relationship between the household dietary diversity score (HDDS) and the household availability of food energy (Hoddinott and Yohannes, 2002). Kennedy et al. (2010) found positive associations between the HDDS and household food consumption scores (Kennedy et al., 2010). At the individual level, positive associations were shown between DD scores and micronutrient

adequacy ratios, and between DD scores and anthropometric measures of women and children (Cisse-Egbuonye et al., 2017; Headey and Ecker, 2013; Ruel et al., 2013). For adult males, the available evidence is scarce. Also, very few studies have compared household level with individual level diet or nutrition indicators. Recent research confirmed positive associations between household level and individual level DD scores in Malawi and Niger (Cisse-Egbuonye et al., 2017; Koppmair et al., 2017). Hatløy et al. (1998) found significant associations between child nutritional status and household level food item counts in an urban area in Mali (Hatløy et al., 1998). Bühler et al. (2017) reported mixed results when comparing child nutritional status and household level food insecurity measures in Cambodia and Laos (Bühler et al., 2017).

We contribute to this literature by comparing a larger set of nutritional indicators at household and individual levels. We use data from rural areas of Western Kenya, where subsistence farming is widespread and rates of malnutrition are relatively high (KNBS, 2015; Mbuvi et al., 2013). At the household level, we carried out a 7d FCR to calculate FVS, DD scores, and household level energy and micronutrient consumption levels. At the individual level, we carried out 24h DR to calculate similar dietary indicators for male and female adults and children. We also collected anthropometric data to measure individual nutritional status.

2.2 Materials and methods

2.2.1 Study area

This study builds on comprehensive data from smallholder farm households in the Western part of Kenya. Specifically, the survey was conducted in the counties of Kisii and Nyamira, where most households are involved in subsistence-oriented farming (Mbuvi et al., 2013). Child undernutrition in this part of Kenya is relatively widespread. According to official statistics, 26% of the children below the age of five were stunted in 2015 (KNBS, 2015). At the same time, almost 30% of the female adults were classified as overweight or obese (KNBS, 2015).

2.2.2 Data collection

We carried out an interview-based household survey in Kisii and Nyamira between October and December 2015. Households to participate in this study were randomly selected in a two-stage procedure. As many of the rural households are organized in farmer groups, we first randomly selected 48 farmer groups (32 groups in Kisii and 16 in Nyamira). Then, in each of the groups, we randomly selected 15-20 households depending on group size. In total, 824 households (557

in Kisii and 267 in Nyamira) were sampled. The interviews were carried out in the local language by a team of interviewers specifically recruited and trained for this study. The interviewers were supervised by the researchers. Households were informed about the date and time of the interview several days in advance.

To capture food consumption at the household level, a 7d FCR was conducted with the person in the household responsible for food preparation. For this recall we used a list of 130 food items commonly consumed in this region. For each food item consumed by the household during the past 7 days, the quantity, source (own production, purchased, gift), and unit price were captured. Of the 824 households, we have complete consumption data for 809 households.

In addition, we collected individual level food intake and anthropometric data of persons living in the sampled households. In each household, we intended to target the household head, the spouse, and one child aged 6-59 months. However, in many households we were unable to obtain data from three individuals, either because a spouse and/or children did not exist or were not living in the same household. In some cases, individuals were absent during the scheduled time of the interview, even in a second attempt. In cases where more than one child aged 6-59 months was living in the household, the child included in the study was chosen randomly. In total, we obtained data from 1,261 adults (782 females and 479 males) and 295 children (147 girls and 148 boys).

Individual level food intake data were collected through a 24h DR. For adults, this recall was carried out twice during two separate meetings. The second recall was taken on a different and non-consecutive day to capture day-to-day variation of food consumption (Savy et al., 2007). During both recalls, participants were asked whether this was a normal or an exceptional day (e.g., celebration or sickness). Recalls of exceptional days were excluded from the analysis (Bingham, 1991; Nelson et al., 2004; Patterson and Pietinen, 2004). To facilitate reporting of all meals and snacks consumed during the recall day, the interviewers provided time frames, from waking up until going to bed. The anthropometric measures were taken during the second meeting and were obtained from 1,046 adults. For children, we only conducted one 24h DR, which was answered by the mother or caretaker. Anthropometric measures were taken from 238 children.

One limitation of both food recall methods, the 7d FCR and the 24h DR, in our cross-section survey is that they do not capture seasonal variation in food consumption (de Haen et al., 2011). However, Kisii and Nyamira receive plenty of rainfall, and agricultural production takes place all year around. Hence, seasonal variation in food consumption may be lower than in many other parts of Africa.

2.2.3 Indicators of diets and nutrition

We use different indicators to measure diets and nutrition at household and individual level. Table 2.1 shows a summary of all indicators used. Additional explanations are provided below.

Nutritional status

Anthropometric data are used to depict the nutritional status of adults and children. Weight and height were measured for all individuals, following recommended techniques (Cogill B, 2003). Lying height was measured for all children under the age of two years using the Seca 417 Height Measuring Board. For adults, BMI was calculated; for the classification of nutritional status, WHO standards were applied (WHO, 2006). For children, Z-scores for weight-for-age (WAZ), weight-for-height (WHZ) and height-for-age (HAZ) were calculated according to the 2006 WHO standards (WHO Multicentre Growth Reference Study Group, 2006). For both, adults and children, individuals with implausibly high or low values due to measurement errors were excluded (Mei and Grummer-Strawn, 2007; WHO Multicentre Growth Reference Study Group, 2006).

Table 2.1 Summary of indicators used to describe diets and nutrition at household and individual level

Nutritional outcome	Indicator	Target group	n	Type of data	Unit of measurement	Cut-off points	Assessment of
Nutritional Status	Anthropo-metrics	Adults (both sexes)	1044	Weight Height	BMI (kg/m²)	WHO (2006)	Nutritional status
		Children (6-59 m)	215		Z-scores	WHO Multicentre Growth Reference Study Group (2006)	
Dietary diversity	DDS [a]	Whole household	809	7d FCR	1-12 FG	No	Economic access to food, measure of FS
		Adults (both sexes)	1026	24h DR		No	
		Children (6-59 m)	271				
	MDD-W [b]	Women (15-49 y)	438	24h DR	1-10 FG	5 or more FG	Probability of micronutrient adequacy, measure of dietary quality
		Adults (both sexes)	1026				
	MDD [c]	Children (6-59 m)	271	24h DR	1-7 FG	4 or more of 7 FG	Measure of dietary quality
	FVS	Whole household	809	7d FCR	Food item count	No	Variety of dietary intake
		Adults (both sexes)	1026	24hDR			
		Children (6-59 m)	271				
Dietary quality	Nutritional intake	Whole household	801	7d FCR	Nutrients in AE	FAO (2004)	Dietary quality, measures of FS, measures of micronutrient adequacy
		Adults (both sexes)	1007	24h DR	Nutrients	IOM (2006)	
		Children (6-59 m)	255				

n, sample size; BMI, body mass index; DDS, dietary diversity score; FCR, food consumption recall; h, hour; DR, dietary recall; FG, food group; FS, food security; MDD-W, minimum dietary diversity for women; MDD, minimum dietary diversity; FVS, food variety score; AE, adult equivalent

[a] FG classification according to Kennedy et al. (2010); [b] FG classification according to FAO and FHI 360 (2016); [c] FG classification according to WHO et al. (2010, 2008).

Dietary diversity

Three different measures of dietary diversity were calculated. First, we use the HDDS with 12 FG to measure dietary diversity at the household level (Kennedy et al., 2010; Swindale and Bilinsky, 2006, 2005). For comparison, we use the same 12 food groups also to calculate a dietary diversity score (DDS) at the individual level for all adults and children. Second, we calculate the minimum dietary diversity for women (MDD-W) with 10 FG (FAO and FHI 360, 2016). The MDD-W is primarily recommended for women of reproductive age (15-49 years). We calculate the MDD-W for these women in our sample (n=438), but additionally also use the same measure for the entire sample of female and male adults (n=1026). Third, for the child sample we calculated the minimum dietary (MDD) score with 7 FG (WHO et al., 2010). Whereas the MDD was primarily developed and validated for young children aged 6-23 months, we use this score for all children in our sample aged 6-59 months (n=271). Table 2.2 shows the classification of FG for the different dietary diversity scores.

In addition to the dietary diversity scores, we use the FVS, where each food item consumed is counted (Chávez Zander, 2014; Keding et al., 2012; Ruel et al., 2013). The FVS is used at the household level as well as for individual adults and children. Table A2.1 in the Online Appendix shows the different food items consumed and the corresponding FG classifications.

Table 2.2 Food groups used to construct different dietary diversity scores

Households, adults and children		Women		Children	
DDS		**MDD-W**		**MDD**	
No	Food group	No	Food group	No	Food group
1	Cereals	1	Grain, white roots and tubers, and plantain	1	Grains, roots, and tubers
2	White roots and tubers	2	Pluses (beans, peas, lentils)	2	Legumes and nuts
3	Vegetables	3	Nuts and seeds	3	Dairy products
4	Fruits	4	Dairy	4	Flesh foods
5	Meat	5	Meat, poultry, and fish	5	Eggs
6	Eggs	6	Eggs	6	VA rich F/V
7	Fish and seafood	7	Dark green vegetables	7	Other F/V
8	Legumes, nuts and seeds	8	Other VA-rich F/V		
9	Milk and milk products	9	Other vegetables		
10	Oil and fats	10	Other fruits		
11	Sweets				
12	Condiments				

DDS, dietary diversity scores; MDD-W, minimum dietary diversity for women; MDD, minimum dietary diversity; VA, vitamin A; F/V, fruit and vegetables

Note: DDS classification according to Kennedy et al. (2010); MDD-W classification according to FAO and FHI 360 (2016); MDD classification according to WHO et al. (2010, 2008).

Nutritional intake

We calculated consumption and intake levels of food energy, macronutrients (protein, fat, carbohydrates), and three micronutrients (vitamin A, zinc, iron) at the household level and at the individual level for male and female adults and children. Deficiencies in vitamin A (VA), zinc, and iron make up the largest share of the health problems caused by micronutrient malnutrition in developing countries (FAO et al., 2017; Lim et al., 2012). Quantities of all food items consumed were converted using the Tanzanian food composition table (Lukmanji et al., 2008), which captures almost all of the food items consumed in Western Kenya. For a few missing food items, other food composition tables were used (Hotz et al., 2012; Sehmi, 1993; Stadlmayr et al., 2012; USDA, 2017). For some of the food items, consumed quantities were reported in non-standard units. We carried out market surveys and weighted typical unit measures for being able to make gram conversions. Food preparation methods were taken into account to the extent possible.

At the household level, energy and nutrient consumption levels are expressed per adult equivalent (AE), taking into account the demographic structure of each household. The AE computations consider age, gender, and levels of physical activity of each household member (FAO, 2004). We use common estimated average requirements (EAR) per AE of energy and micronutrients to classify households as nutritionally deficient (Chege et al., 2015; Chiputwa and Qaim, 2016). For energy, a household is classified as undernourished if the consumption is below 10,042 kJ (2400 kcal) per AE and day (FAO, 2004). For the micronutrients, the AE thresholds are 625 µg of retinol equivalent for VA, 15.0 mg for zinc, and 18.3 mg for iron (WHO and FAO, 2004). In total, 801 households are included in this household level energy and nutrient consumption analysis, 8 households where excluded due to missing information on consumed quantities of certain food items.

At the individual level, EAR thresholds for energy and micronutrients take into account the age and gender of the individual adult or child, for energy individual weight is additionally considered (IOM, 2006). In total, individual nutritional intake was calculated for 1007 adults and 255 children. Several individuals had to be excluded due to missing information for specific intake parameters.

Statistical analysis

The data were analysed with the software package Stata 13.1. We show descriptive statistics for the different dietary and nutritional indicators at household and individual levels. To analyze the association between the indicators, we compute correlation coefficients and use Pearson's correlation coefficient test for statistical significance (Hatløy et al., 2000, 1998; Kennedy et al., 2010; Kennedy et al., 2007; Rathnayake et al., 2012; Steyn et al., 2006; Torheim et al., 2004). We are particularly interested in the associations between different types of dietary indicators and the associations between dietary indicators and nutritional status at the individual level. Furthermore, we are interested in the associations between dietary indicators at the household level and similar dietary indicators at the individual level, as these results can help to judge whether household level indicators can be used as valid proxies for individual diets and nutrition.

2.3 Results

Nutritional status

The average household in our sample has 5.26 (SD 2.04) household members, including adults and children. Anthropometric indicators for the individual household members are shown in Table A2 in the Online Appendix. The male and female adults included in the sample have a mean age of 45 years (SD 13.12), a mean weight of 64.97 kg (SD 12.57), and a mean height of 163.13 cm (SD 7.79). The average adult BMI is 24.4 kg/m² (SD 4.57). Forty percent of the adults included in this study have a BMI above 25 kg/m^2 and are therefore classified as overweight. Overweight is significantly more widespread among women (46%) than among men (28%). Only 6% of the adults are classified as underweight with a BMI smaller than 18.5 kg/m².

The children included in the sample have a mean age of 32 months (SD 14.58), a mean weight of 12.92 kg (SD 3.15), and a mean height of 89.02 cm (12.46). Nineteen percent of the children are stunted, 75% are underweight, and 1% are wasted. Only a very small percentage of the children are classified as overweight.

Dietary diversity

Descriptive statistics of the different dietary diversity and food variety indicators calculated at household and individual levels are summarized in Table 2.3. The average household consumed 9.4 different FG during the 7d recall period. Cereals and vegetables were consumed by all households. Within the group of cereals, the consumption of maize flour was reported most frequently (98%), followed by white rice (75%). The least consumed FG was fish and seafood (Figure 1).

At the individual level, both adults and children consumed around 6 FG during the 24h recall period on average, when using the 12 FG classifications to calculate the DDS. The MDD-W and MDD scores are lower, as one would expect given the different FG classifications. In the adult sample, all individuals consumed cereal-based food items – mostly *ugali* (a thick porridge made from maize flour). Eggs and seafood were only consumed by 5% of the sample. In the child sample, almost all individuals consumed some form of staple foods (cereals, roots, or tubers), 94% consumed at least one type of vegetable (Figure 2.1). The most widely consumed vegetable is tomato.

For the MDD-W and the MDD, critical levels were established as guidelines for healthy and balanced nutrition (FAO and FHI 360, 2016; WHO et al., 2010, 2008). Women of reproductive age should have MDD-W ≥ 5 FG to guarantee an adequate intake of all required nutrients (FAO and FHI 360, 2016). The mean MDD-W of women of reproductive age in our sample is 4.79 (Table 2.3). Thirty-four percent of the women remain below the critical level of 5 FG. For the combined sample of male and female adults (n=1026), the picture is similar with a mean MDD-W of 4.71 (SD 0.99). Children should have MMD ≥ 4 for a healthy diet (WHO et al., 2010, 2008). Twenty-six percent of the children in our sample remain below this critical level. Also, when we confine the sample to children aged 6-23 months (n=75), the picture remains similar (mean 3.89; SD 1.06).

Table 2.3 Descriptive statistics for dietary diversity measures

Indicator	Household (n=809)	Adult (n=1026)	Child (n=271)
DDS (12 FG)			
Mean	9.41	6.09	6.32
SD	1.44	1.06	1.29
Range	4 - 12	2 – 10	1 – 9
MDD-W (10 FG; n=438)			
Mean		4.79	
SD		0.99	
Range		2 - 7	
MDD (7 FG)			
Mean			3.94
SD			0.95
Range			1 – 6
FVS			
Mean	22.45	10.48	10.66
SD	6.20	2.05	2.69
Range	7 - 55	3 - 20	1 – 19

n, sample size; DDS, dietary diversity score; FG, food group; SD, standard deviation; MDD-W, minimum dietary diversity for women; MDD, minimum dietary diversity for children; FVS, food variety score

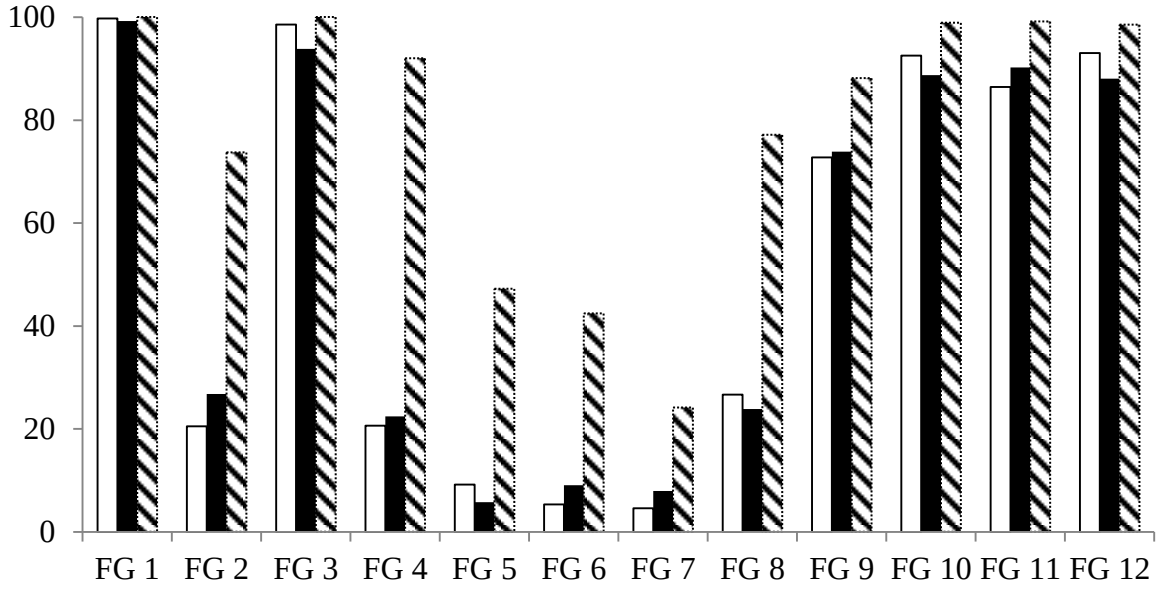

Figure 2.1 Food group distribution in percentage terms (based on 12 food group classification). ☐ adults, ■ children, ▨ household

Note: Sample size of adults (n=1026). Sample size of children (n=271). Sample size of households (n=809).

(FG food groups; FG 1 cereals; FG 2 white roots & tubers; FG 3 vegetables; FG 4 fruits; FG 5 meat; FG 6 eggs; FG 7 fish & seafood; FG 8 legumes, nuts & seeds; FG 9 milk & milk products; FG 10 oils & fats; FG 11 sweets; FG 12 spices, condiments & beverages)

Nutritional intake

Table 2.4 reports the average consumption of energy and nutrients at the household level and for individual household members. At the household level, 33% of the sample are classified as undernourished in terms of food energy. At the individual level, the calculated rates of energy undernourishment are significantly higher, 72% for adults and 53% for children. Also for micronutrient consumption levels and deficiency rates, we observe notable differences between the household level and the individual level estimates. While the household level data point to a widespread iron deficiency, the individual level estimates suggest that zinc deficiency is much more prevalent (Table 2.4).

Table 2.4 Dietary intake at household, adult, and child level

	Mean	SD	Def. level [a, b]
Household per AE (n=801)			
Energy (kJ/d)	12739.29	6384.79	
(kcal/d)	(3283.77)	(1526.00)	0.33
Iron (mg/d)	13.32	6.91	0.83
Zinc (mg/d)	25.21	13.12	0.18
VA (µg/d)	2094.29	2346.60	0.15
Adult (n=1007)			
Energy (kJ/d)	9336.98	3942.51	
(kcal/d)	(2231.59)	(942.28)	0.72
Protein (g/d)	55.02	25.79	
Carbohydrate (g/d)	392.23	181.72	
Fat (g/d)	63.00	42.10	
Iron (mg/d)	15.83	6.84	0.06
Zinc (mg/d)	8.04	3.71	0.53
VA (µg/d)	1419.94	783.91	0.10
Child (n=255)			
Energy (kJ/d)	7227.74	4109.66	
(kcal/d)	(1727.47)	(982.09)	0.53
Protein (g/d)	38.23	26.80	
Carbohydrate (g/d)	299.67	178.73	
Fat (g/d)	51.14	38.74	
Iron (mg/d)	10.43	8.42	0.11
Zinc (mg/d)	5.33	4.06	0.27
VA (µg/d)	890.29	590.15	0.06

AE, adult equivalent; n, sample size; SD, standard deviation, Def, deficiency; kJ, kilojoule; d, day; VA, vitamin A

[a] Proportion of households below estimated average requirements according to FAO (2004); [b] Proportion of individuals below estimated average requirements according to IOM (2006)

2.3.1 Association of indicators

Correlation coefficients between all the different indicators at household and individual levels are shown in Tables A2.5 and A2.6 in the Online Appendix. The correlations of particular interest are summarized in Tables 2.5-2.9 and are discussed in more detail in the following.

Table 2.5 reports the correlation coefficients between the different dietary indicators at the household level. All of the correlations are positive and statistically significant. As expected, DDS is strongly correlated with FVS. Somewhat more surprising is the fact that micronutrient consumption is more strongly correlated with energy consumption than with either DDS or FVS. The reason is that the energy indicator takes into account the quantity of food items consumed, whereas DDS and FVS do not.

Table 2.5 Correlations between household dietary indicators

		Household	
	DDS	FVS	Energy Intake (kJ/d/AE)
Household			
FVS (n=809)	0.7099***	1	
Energy intake (kJ/d/AE; n=801)	0.2723***	0.3432***	1
VA (µg/d/AE; n=801)	0.1100**	0.2137***	0.4203***
Zinc (mg/d/AE; n=801)	0.1264***	0.1793***	0.7851***
Iron (mg/d/AE; n=801)	0.2261***	0.2907***	0.7442***

DDS, dietary diversity score; FVS, food variety score; kJ, kilojoule; d, day; AE, adult equivalent; n, sample size; VA, vitamin A
*p<0.1, **p<0.05, ***p<0.01

Correlation coefficients between the individual level dietary and nutrition indicators for adults are reported in Table 2.6. All of the correlations for the different dietary indicators are positive and statistically significant. The correlations between the different dietary diversity and food variety scores are particularly strong, suggesting that the use of dietary indicators with different FG classifications lead to similar conclusions. However, most of the correlations between the dietary indicators and BMI are very small and not statistically significant. BMI is even negatively associated with some of the dietary indicators. This is not necessarily surprising for the micronutrients, as overweight and micronutrient malnutrition can occur simultaneously in the same individual. However, BMI is also negatively correlated with energy consumption and positively correlated with being undernourished, which is counterintuitive.

Table 2.6 Correlations between different dietary and nutrition indicators for adults

			Adult		
	DDS	FVS	MDD-W (women)	MDD-W (both sex)	Energy (kJ/d)
Adult					
FVS (n=1026)	0.7412***	1			
MDD-W (women, n=438)	0.6866***	0.7084***	1		
MDD-W (both sexes; n=1026)	0.7074***	0.7386***	1.0000***	1	
Energy (kJ/d; n=1007)	0.2592***	0.2886***	0.2204***	0.2467***	1
Undernourished (0/1; n=828)	-0.1884***	-0.1826***	-0.1906***	-0.1855***	-0.7194***
Protein (g/d; n=1007)	0.3186***	0.3131***	0.3269***	0.3360***	0.8130***
Fat (g/d; n=1007)	0.3044***	0.3256***	0.3234***	0.3273***	0.6831***
Carbohydrate (g/d; n=1007)	0.1579***	0.1910***	0.1024**	0.1152***	0.9014***
VA (µg/d; n=1007)	0.1285***	0.1886***	0.2133***	0.2019***	0.2372***
Zinc (mg/d; n=1007)	0.1818***	0.1795***	0.1926***	0.2235***	0.7370***
Iron (mg/d; n=1007)	0.1549*	0.1501***	0.1878***	0.1964***	0.7540***
BMI (kg/m²); n=840)	-0.0097	0.051	0.0225	0.0549	-0.0600*

DDS, dietary diversity score; FVS, food variety score; MDD-W, minimum dietary diversity for women; kJ, kilojoule; d, day; BMI, body mass index; n, sample size; VA, vitamin A
*p<0.1, **p<0.05, ***p<0.01

Correlation coefficients between the individual level dietary and nutrition indicators for children are reported in Table 2.7. As for the adult sample, all of the correlations for the different dietary indicators are positive and statistically significant. MDD is correlated more strongly with micronutrient intakes than DDS and is therefore a better proxy of child dietary quality. However, as for the adult sample, we observe that most of the correlation coefficients between the child dietary indicators and the anthropometric measures are statistically insignificant. The only exception is the positive correlation between energy intake and HAZ. We infer that dietary indicators are not suitable proxies for nutritional status, neither for adults nor for children.

Table 2.7 Correlations between different dietary and nutrition indicators for children

	Child			
	DDS	MDD	FVS	Energy (kJ/d)
Child				
MDD (n=271)	0.7392***	1		
FVS (n=271)	0.7672***	0.6550***	1	
Energy (kJ/d; n=255)	0.2785***	0.2638***	0.3250***	1
Protein (g/d; n=255)	0.2096***	0.2907***	0.2254***	0.7788***
Fat (g/d; n=255)	0.2894***	0.3142***	0.2879***	0.7496***
Carbohydrate (g/d; n=255)	0.2162**	0.1655**	0.2906***	0.9310***
VA (µg/d; n=255)	0.2181***	0.1874***	0.2761***	0.3722***
Zinc (mg/d; n=255)	0.1150*	0.1968***	0.1423**	0.7433***
Iron (mg/d; n=255)	0.1176*	0.1844***	0.1499**	0.7545***
WAZ (n=210)	0.0009	0.0989	0.0178	0.064
HAZ (n=201)	-0.0387	0.0715	-0.0177	0.1515**
WHZ (n=199)	0.0771	0.0812	0.0497	-0.0933

DDS, dietary diversity score; MDD, minimum dietary diversity; FVS, food variety score; kJ, kilojoule; d, day; n, sample size; WAZ, weight for age Z-score; HAZ, height for age Z-score; WHZ, weight for height Z-score
**p<0.1, **p<0.05, ***p<0.01*

2.3.2 Association between household, adult, and child indicators

Results for the correlations between the dietary indicators at the household level and the dietary and nutrition indicators at the individual level are shown in Table 2.8 and 2.9. focuses on the results for adults. Household DDS and FVS are positively and significantly correlated with all individual level dietary indicators. Similarly, other household level dietary indicators are positively correlated with most other individual level dietary indicators, including micronutrient intakes (see also Table A2.5). Household DDS is not significantly correlated with adult BMI. However, household FVS and also household calorie consumption are positively and significantly correlated with adult BMI, suggesting that household level dietary indicators may be better proxies for adult nutritional status than individual level dietary indicators (compare with results in Table 2.6). Most of these results also hold when we consider male and female adults separately (Tables A2.3 and A2.4 in the Online Appendix).

Table 2.8 Correlations between household level and individual level indicators for adults

	Household		
	DDS	FVS	Energy (kJ/d/AE)
Adult			
DDS (n=1012)	0.2745***	0.2506***	0.1342***
FVS (n=1012)	0.2953***	0.3171***	0.1883***
MDD-W (n=436)	0.2502***	0.3036***	0.1328***
Energy (kJ/d; n=993)	0.1923***	0.1811***	0.1957***
Protein (g/d; n=993)	0.2109***	0.1659***	0.2060***
Fat (g/d; n=993)	0.1719***	0.1772***	0.1698***
Carbohydrate (g/d; n=993)	0.1533***	0.1373***	0.1683***
VA (µg/d; n=993)	0.0702**	0.0784**	0.00160
Zinc (mg/d; n=993)	0.1408***	0.1229***	0.1354***
Iron (mg/d; n=993)	0.1546***	0.1180***	0.1209***
BMI (kg/m²; n=1032)	0.0490	0.0948***	0.1028***

DDS, dietary diversity score; FVS, food variety score; d, day; AE, adult equivalent; n, sample size; MDD-W, minimum dietary diversity for women; BMI, body mass index
**p<0.1, **p<0.05, ***p<0.01*

Table 2.9 shows the results for children. Household DDS and FVS are positively and significantly correlated with the individual level dietary diversity indicators. However, household DDS is not significantly correlated with child micronutrient intakes. In contrast, household energy consumption and also household micronutrient consumption levels are positively and significantly correlated with child micronutrient intakes (see also Table A2.6), suggesting that the household level indicators that take into account the quantity of food items consumed are better proxies of child dietary quality than household DDS. Concerning child nutritional status, some of the household level dietary indicators are significantly correlated with the weight-based measures (WAZ, WHZ), but not with HAZ.

Table 2.9 Correlations between household level and individual level indicators for children

	Household		
	DDS	FVS	Energy (kJ/d/AE)
Child			
DDS (n=269)	0.3094***	0.3335***	0.1521***
MDD (n=269)	0.2730***	0.3213***	0.1990***
FVS (n=269)	0.2946***	0.3859***	0.2110***
Energy (kJ/d; n=269)	0.1790***	0.2637***	0.1440**
Protein (g/d; n=269)	0.1096*	0.1993***	0.1753***
Fat (g/d; n=269)	0.1078*	0.2529***	0.1272**
Carbohydrate (g/d; n=269)	0.1738***	0.2133***	0.1123*
VA (µg/d n=269)	0.0479	0.1586**	0.0633
Zinc (mg/d; n=269)	0.0795	0.1309**	0.1566**
Iron (mg/d; n=269)	0.0478	0.103	0.1301**
WAZ (n=224)	0.1322*	0.1540**	0.2022**
HAZ (n=214)	0.107	0.0816	0.0858
WHZ (n=212)	0.0794	0.1266*	0.1580**

DDS, dietary diversity score; FVS, food variety score; d, day; AE, adult equivalent; n, sample size; MDD, minimum dietary diversity; WAZ, weight for age Z-score; HAZ, height for age Z-score; WHZ, weight for height Z-score
**p<0.1, *p<0.05, ***p<0.01*

2.4 Discussion

In this paper, we have calculated and compared a large set of dietary and nutrition indicators based on household level and individual level data collected for the same target population in rural areas of Western Kenya. Different indicators lead to different results, underlining that the methods of data collection and the concrete metrics used in a particular study matter, especially when the main intention is to describe levels of malnutrition. For instance, household level calculations based on 7d FCR data resulted in significantly lower levels of energy undernourishment than individual level calculations based on 24h DR data. Both food recall-based methods grossly overestimated the rates of undernutrition calculated with anthropometric measures for adults; for children, where various anthropometric indicators were used the differences were less systematic.

Beyond comparing results, we were also interested in better understanding the associations between the different indicators used. Even when the results of different indicators differ in absolute terms, positive correlations would suggest that certain indicators can be used as proxies for others, at least when the main intention is to simply evaluate the direction of dietary and

nutrition effects of particular interventions. Within the same target group, all dietary indicators are positively correlated at a high level of statistical significance. This means that dietary diversity and food variety scores calculated from individual 24h recall data are valid proxies of micronutrient intakes for adults and children. This is consistent with several previous studies that had tested similar associations in different geographical contexts (Hatløy et al., 1998; Kennedy et al., 2007; Moursi et al., 2008; Steyn et al., 2006; Torheim et al., 2004).

However, most of the correlations between the individual level dietary data and the anthropometric measures were very small and statistically insignificant, suggesting that dietary indicators are not good proxies of nutritional status, neither for adults nor for children. This is in contrast to a few earlier studies that had shown significant associations between dietary diversity indicators and child and women nutritional status based on data from various countries (Arimond and Ruel, 2004; Ruel et al., 2013). It seems that results are context-specific and that general conclusion about the suitability of dietary data to proxy for nutritional status are not possible.

We have also analyzed the associations between different indicators across household and individual levels, which have rarely been done before. Household dietary diversity and food variety scores are positively correlated with individual level dietary diversity and food variety scores for children and also for male and female adults. This is particularly noteworthy because most other studies have not collected dietary and nutrition data for adult men. Similarly, energy and micronutrient consumption levels at the household level are positively correlated with individual level energy and micronutrient intakes for all target groups. Interestingly, the household level dietary indicators were also correlated more closely with some of the adult and child anthropometric measures than the individual dietary data. We conclude that data from 7d FCR at the household level can be used to calculate valid proxies of the diets of children and male and female adults when individual level 24h DR data are not available. This is an important result, because household level 7d FCR are often included in nationally representative household living standard monitoring surveys, whereas individual level 24h DR are not.

2.5 Appendix A2

Table A2.1 Food group classifications and corresponding food items

1	Cereals		Maize porridge, white rice, *ugali*, millet porridge, *chapati*, maize flour, *mandazi*, sorghum, millet flour, sorghum powder, wheat flour, sorghum flour, cassava flour, bread, brown wheat flour, brown rice, pasta/spaghetti
2	White roots & tubers		Sweet potatoes, Irish potatoes, cassava, chips, arrow roots, cooking banana
3	Vegetables	VA rich vegetables & tubers	Tomato, pumpkin, carrots, beetroot,
		Dark green leafy vegetables	Pumpkin leaves (*Risosa*), kales(Sukuma Wiki), amaranth (*Emboga*), black night shade (*Managu*), cow pea leaves, vine spinach, spider plant (*Sagaa*), jute mallow, bean leaves, spinach
		Other vegetables	Onion, green maize, cabbage, spring onions, maize, dry maize, mushrooms, capsicum (*pili pili hoho*), garlic
4	Fruits	VA rich fruits	Guava, ripe paw paw, orange, ripe mango, tangerine
		Other fruits	banana, avocado, passion fruit, lemon fruits, apple, pineapple, watermelon, ripe banana, tree tomato
5	Meat	Organ meat	*Matumbo*
		Flesh meat	Goat meat, beef, chicken, sausages
6	Eggs		Eggs
7	Fish & seafood		Sardines (*Dagaa/Omena*), fish
8	Legumes, nuts & seeds		Beans, soya powder, soya meat, green grams, cow peas, groundnuts, peas, soya bean,
9	Milk & milk products		Sour milk, milk
10	Oils & fats		Cooking oil, margarine, fat, butter
11	Sweets		Sugar, sugarcane, molasses, chocolate, juices, soda, cake, sweets
12	Spices, condiments & beverages		Salt, strong tea, tea/milk tea, tea leaves, cocoa, drinking chocolate, *royco cube*, coffee, coriander (*Dania*), baking powder, yeast, parsley, beer, ginger, local beer, pepper, sorghum drink

VA, Vitamin A

Table A2.2 Adult and child measurements

	n	Mean	SD	Min	Max
Adult					
Age (year)	1464	44.98	13.12	14.00	83.00
wt (kg)	1044	64.97	12.57	37.20	123.00
ht (cm)	1044	163.13	7.79	131.00	188.00
BMI (kg/m²)	1044	24.44	4.57	15.47	44.38
Overweight (1/0)	1044	0.40	0.49	0.00	1.00
Underweight (1/0)	1044	0.06	0.24	0.00	1.00
Child					
Age (month)	215	32.27	14.84	6.00	59.00
wt (kg)	215	12.92	3.18	5.40	22.90
ht (cm)	215	89.02	12.46	63.50	122.15
WAZ	215	-0.25	1.13	-4.28	2.27
HAZ	215	-0.63	1.69	-4.67	4.11
WHZ	213	0.15	0.96	-4.74	2.19

n, sample size; SD, standard deviation; wt, weight; ht, height; BMI, body mass index; WAZ, weight for age Z-score; HAZ, height for age Z-score; WHZ, weight for height Z-score

Table A2.3 Pairwise correlation between household level indicators and individual level indicators for female adults

	Household		
	DDS	FVS	Energy (kJ/d/AE)
Female			
DDS (n=631)	0.3200***	0.2900***	0.1488***
FVS (n=631)	0.3149***	0.3359***	0.1689***
MDD-W (n=436)	0.2502***	0.3036***	0.1328**
MDD-W (all women; n=631)	0.2827***	0.3052***	0.1259***
Energy (kJ/d ; n=626)	0.2249***	0.2137***	0.1806***
Protein (g/d; n=626)	0.2412***	0.2032***	0.1780***
Fat (g/d; n=626)	0.1996***	0.2250***	0.1217***
Carbohydrate (g/d; n=626)	0.1780***	0.1532***	0.1697***
VA (μg/d; n=626)	0.1211***	0.1043**	-0.0248
Zinc (mg/d; n=626)	0.1640***	0.1412***	0.1045**
Iron (mg/d; n=626)	0.1549***	0.1204***	0.0877**
BMI (kg/m²; n=668)	0.0736*	0.1337***	0.1189***

DDS, dietary diversity score; FVS, food variety score; kJ, kilojoule; n, sample size; d, day; AE, adult equivalent; MDD-W, minimum dietary diversity for women; BMI, body mass index
*p<0.1, **p<0.05, ***p<0.01

Table A2.4 Pairwise correlation between household level indicators and individual level indicators for male adults

	Household		
	DDS	FVS	Energy (kJ/d/AE)
Male			
DDS (n=381)	0.2039***	0.1920***	0.1131**
FVS (n=381)	0.2640***	0.2886***	0.2185***
MDD-W (male; n=381)	0.1878***	0.1723***	0.1330**
Energy Intake (kJ/d; n=367)	0.1387**	0.1273**	0.2102***
Protein (g/d; n=367)	0.1744***	0.1157**	0.2352***
Fat (g/d; n=367)	0.1298**	0.1075**	0.2241***
Carbohydrate (g/d; n=367)	0.1100**	0.1086*	0.1627***
VA (µg/d; n=367)	0.0004	0.0447	0.0339
Zinc (mg/d; n=367)	0.1085***	0.0933*	0.1647***
Iron (mg/d; n=367)	0.1497***	0.1078**	0.1656***
BMI (kg/m²; =364)	0.0392	0.0482	0.1043*

DDS, dietary diversity score; FVS, food variety score; kJ, kilojoule; n, sample size; d, day; AE, adult equivalent; MDD-W, minimum dietary diversity for women (here calculated for men); BMI, body mass index

*p<0.1, **p<0.05, ***p<0.01

Table A2.5 Pairwise correlation between household level indicators and individual level indicators for adults

			Household							Adult												
			DDS	FVS	Energy intake (kcal/d/AE)	Energy intake (kJ/d/AE)	VA (µg/d/AE)	Zinc (mg/d/AE)	Iron (mg/d/AE)	DDS	FVS	MDD-W	MDD-W (both sexes)	BMI (kg/m²)	Overweight (Dummy BMI ≥25 0)	Underweight (Dummy BMI <18 5)	Energy Intake (kcal/d)	Energy Intake (kJ/d)	Energy (kcal/d) without outliers (IQR)	Energy intake (kcal/d) without outliers (mean)	Undernourished (<2400 kcal (0/1))	Undernourished ((FAO (0/1))
Household	FVS	r	0.7099***	1																		
		p	0.00																			
		n	809	809																		
	Energy intake (kcal/d/AE)	r	0.2723***	0.3432***	1																	
		p	0.00	0.00																		
		n	801	801	801																	
	Energy intake (kJ/d/AE)	r	0.2723***	0.3432***	1.0000***	1																
		p	0.00	0.00	0.00	0.00																
		n	801	801	801	801																
	VA (µg/d/AE)	r	0.1100***	0.2137***	0.4203***	0.4203***	1															
		p	0.00	0.00	0.00	0.00	0.00															
		n	801	801	801	801	801															
	Zinc (mg/d/AE)	r	0.1264***	0.1793***	0.7851***	0.7851***	0.5134***	1														
		p	0.00	0.00	0.00	0.00	0.00	0.00														
		n	801	801	801	801	801	801														
	Iron (mg/d/AE)	r	0.2261***	0.2907***	0.7442***	0.7442***	0.5467***	0.6741***	1													
		p	0.00	0.00	0.00	0.00	0.00	0.00	0.00													
		n	801	801	801	801	801	801	801													
Adult	DDS	r	0.2745***	0.2506***	0.1342***	0.1342***	0.1195***	0.0722**	0.1226***	1												
		p	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00												
		n	1012	1012	1002	1002	1002	1002	1002	1026												
	FVS	r	0.2953***	0.3171***	0.1883***	0.1883***	0.1003***	0.1001**	0.1586***	0.7412***	1											
		p	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00											
		n	1012	1012	1002	1002	1002	1002	1002	1026	1026											
	MDD-W	r	0.2502***	0.3036***	0.1328**	0.1328**	0.1200**	0.0606	0.0999**	0.6866***	0.7084***	1										
		p	0.00	0.00	0.01	0.01	0.01	0.21	0.04	0.00	0.00	0.00										
		n	436	436	432	432	432	432	432	438	438	438										
	MDD-W (both sexes)	r	0.2481***	0.2548***	0.1296***	0.1296***	0.0943***	0.0529*	0.1015***	0.7074***	0.7386***	1.0000***	1									
		p	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00									
		n	1012	1012	1002	1002	1002	1002	1002	1026	1026	438	1026									
	BMI (kg/m²)	r	0.049	0.0948**	0.1028***	0.1028***	0.0947***	0.0670**	0.0705**	-0.0097	0.051	0.0225	0.0549	1								
		p	0.12	0.00	0.00	0.00	0.00	0.03	0.02	0.78	0.14	0.67	0.11	0.00								
		n	1032	1032	1022	1022	1022	1022	1022	840	840	369	840	1044								
	Overweight (Dummy BMI ≥25 0)	r	0.0348	0.0601*	0.0569*	0.0569*	0.0834**	0.0369	0.0431	-0.0238	-0.0097	0.0116	0.0233	0.8007***	1							
		p	0.26	0.05	0.07	0.07	0.01	0.24	0.17	0.49	0.78	0.82	0.50	0.00	0.00							
		n	1032	1032	1022	1022	1022	1022	1022	840	840	369	840	1044	1044							
	Underweight (Dummy BMI <18 5)	r	-0.0191	-0.0489	-0.0509	-0.0509	-0.0073	-0.0226	-0.0161	-0.0074	-0.0664*	-0.0766	-0.0547	-0.3823***	-0.2041***	1							
		p	0.54	0.12	0.10	0.10	0.82	0.47	0.61	0.83	0.05	0.14	0.11	0.00	0.00	0.00						
		n	1032	1032	1022	1022	1022	1022	1022	840	840	369	840	1044	1044	1044						
	Energy intake (kcal/d)	r	0.1923***	0.1811***	0.1957***	0.1957***	0.0695**	0.0960***	0.1079***	0.2592***	0.2886***	0.2204***	0.2467***	-0.0600*	-0.0724**	0.0404	1						
		p	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.04	0.25						
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007					
	Energy intake (kJ/d)	r	0.1923***	0.1811***	0.1957***	0.1957***	0.0695**	0.0960**	0.1079**	0.2592***	0.2886***	0.2204***	0.2467***	-0.0600**	-0.0724**	0.0404	1.00***	1					
		p	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.04	0.25	0.00					
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007				
	Energy intake (kcal/d)without outliers (IQR)	r	0.2081***	0.1942***	0.1845***	0.1845***	0.0750**	0.0931***	0.1109***	0.2689***	0.2871***	0.2371***	0.2569***	-0.0612*	-0.0876**	0.0121	1.00***	1.00***	1				
		p	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.73	0.00	0.00	0.00			
		n	988	988	979	979	979	979	979	1002	1002	432	1002	825	825	825	1002	1002	1002			
	Energy intake (kcal/d)without outliers (mean)	r	0.1787***	0.1813***	0.1604***	0.1604***	0.0502	0.0687**	0.0904**	0.2383***	0.2692***	0.2163***	0.2385***	-0.0511	-0.0669*	0.021	1.00*	1.00***	1.00***	1			
		p	0.00	0.00	0.00	0.00	0.12	0.03	0.01	0.00	0.00	0.00	0.00	0.15	0.06	0.55	0.00	0.00	0.00	0.00		
		n	956	956	947	947	947	947	947	968	968	422	968	804	804	804	968	968	966	968		
	Undernourished (<2400 kcal (0/1))	r	-0.1250***	-0.1418***	-0.1368***	-0.1368***	-0.0657**	-0.0885**	-0.0841**	-0.1861***	-0.2028***	-0.1749***	-0.1882***	0.0399	0.0528	-0.0579	-0.7561***	-0.7561***	-0.7784***	-0.7984***	1	
		p	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.25	0.13	0.10	0.00	0.00	0.00	0.00	0.00	
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	
	Undernourished ((FAO (0/1))	r	-0.0951**	-0.1277***	-0.0907**	-0.0907**	-0.039	-0.0825**	-0.0341	-0.1884***	-0.1826***	-0.1906***	-0.1855***	0.1505***	0.1466***	-0.0988**	-0.7194***	-0.7194***	-0.7447***	-0.7334***	0.7714***	1
		p	0.01	0.00	0.01	0.01	0.27	0.02	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		n	820	820	812	812	812	812	812	829	829	366	829	828	828	828	829	829	826	805	829	829
	Protein (g/d)	r	0.2109***	0.1659***	0.2060***	0.2060***	0.1199***	0.1208***	0.1382***	0.3186***	0.3131***	0.3269***	0.3360***	-0.0646*	-0.0749**	0.0153	0.8130***	0.8130***	0.8279***	0.7892***	-0.6233***	-0.5996***
		p	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.66	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829
	Fat (g/d)	r	0.1719***	0.1772***	0.1698***	0.1698***	0.041	0.0385	0.0631*	0.3044***	0.3256***	0.3234***	0.3273***	-0.0325	-0.0259	-0.0418	0.6831***	0.6831***	0.7024***	0.6512***	-0.5156***	-0.4938***
		p	0.00	0.00	0.00	0.00	0.20	0.23	0.05	0.00	0.00	0.00	0.00	0.35	0.46	0.23	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829
	Carbohydrate (g/d)	r	0.1533***	0.1373***	0.1683***	0.1683***	0.0750***	0.1096***	0.1110***	0.1579***	0.1910***	0.1024**	0.1152***	-0.0529	-0.0707**	0.0760**	0.9014***	0.9014***	0.8908***	0.8939***	-0.6689***	-0.6336***
		p	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.03	0.00	0.13	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829
	VA (µg/d)	r	0.0702**	0.0784**	0.0016	0.0016	0.1468***	-0.017	0.052	0.1285***	0.1886***	0.2133***	0.2019***	-0.0212	-0.0124	-0.0266	0.2372***	0.2372***	0.2475***	0.2593***	-0.2197***	-0.1595***
		p	0.03	0.01	0.96	0.96	0.00	0.59	0.10	0.00	0.00	0.00	0.00	0.54	0.72	0.45	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829
	Zinc (mg/d)	r	0.1408***	0.1229***	0.1354***	0.1354***	0.0733**	0.0817**	0.1020***	0.1818***	0.1795***	0.1926***	0.2235***	-0.0843**	-0.1015***	0.0441	0.7370***	0.7370***	0.7585***	0.7538***	-0.5941***	-0.5699***
		p	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829
	Iron (mg/d)	r	0.1546*	0.1180***	0.1209***	0.1209***	0.0568*	0.0768**	0.0886**	0.1549*	0.1501***	0.1878***	0.1964***	-0.0757**	-0.0994**	0.0371	0.7540***	0.7540***	0.7818***	0.7628***	-0.6106***	-0.5821***
		p	0.00	0.00	0.00	0.00	0.07	0.02	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00
		n	993	993	984	984	984	984	984	1007	1007	433	1007	828	828	828	1007	1007	1002	968	1007	829

DDS, dietary diversity score; FVS, food variety score; d, day; VA, vitamin A; MDD-W, minimum dietary diversity for women; BMI, body mass index;
**p<0.1, **p<0.05, ***p<0.01*

Table A2.6 Pairwise correlation between household level indicators and individual level indicators for children

			Household							Child						
			DDS	FVS	Energy intake (kcal/d/AE)	Energy intake (kJ/d/AE)	VA (µg/d/AE)	Zinc (mg/d/AE)	Iron (mg/d/AE)	DDS	MDD	FVS	Energy intake (kcal/d)	Energy intake (kJ/d)	Energy intake (kcal/d) without outliers (IQR)	Energy Intake (kcal/d) without outliers (mean)
Household	FVS	r	0.7099***	1												
		p	0.00													
		n	809	809												
	Energy intake (kcal/d/AE)	r	0.2723***	0.3432***	1											
		p	0.00	0.00												
		n	801	801	801											
	Energy intake (kJ/d/AE)	r	0.2723***	0.3432***	1.0000***	1										
		p	0.00	0.00	0.00	0.00										
		n	801	801	801	801										
	VA (µg/d/AE)	r	0.1100**	0.2137***	0.4203***	0.4203***	1									
		p	0.00	0.00	0.00	0.00										
		n	801	801	801	801	801									
	Zinc (mg/d/AE)	r	0.1264***	0.1793***	0.7851***	0.7851***	0.5134***	1								
		p	0.00	0.00	0.00	0.00	0.00	0.00								
		n	801	801	801	801	801	801								
	Iron (mg/d/AE)	r	0.2261***	0.2907***	0.7442***	0.7442***	0.5467***	0.6741***	1							
		p	0.00	0.00	0.00	0.00	0.00	0.00	0.00							
		n	801	801	801	801	801	801	801							
Individual child	DDS	r	0.3094***	0.3335***	0.1521**	0.1521**	0.1752**+	0.101	0.1223*	1						
		p	0.00	0.00	0.01	0.01	0.00	0.10	0.05	0.00						
		n	269	269	266	266	266	266	266	271						
	MDD	r	0.2730***	0.3213***	0.1990***	0.1990***	0.1309**	0.1407**	0.1241**	0.7392***	1					
		p	0.00	0.00	0.00	0.00	0.03	0.02	0.04	0.00	0.00					
		n	269	269	266	266	266	266	266	271	271					
	FVS	r	0.2946***	0.3859***	0.2110***	0.2110***	0.1472**	0.1236**	0.1665**	0.7672***	0.6550***	1				
		p	0.00	0.00	0.00	0.00	0.02	0.04	0.01	0.00	0.00	0.00				
		n	269	269	266	266	266	266	266	271	271	271				
	Energy (kcal/d)	r	0.1790**	0.2637***	0.1440**	0.1440**	0.0716	0.0878	0.1807***	0.2785***	0.2638***	0.3250***	1			
		p	0.00	0.00	0.02	0.02	0.26	0.17	0.00	0.00	0.00	0.00	0.00			
		n	254	254	251	251	251	251	251	255	255	255	255			
	Energy (kJ/d)	r	0.1790***	0.2637***	0.1440**	0.1440**	0.0716	0.0878	0.1807**	0.2785***	0.2638***	0.3250***	1.000***	1		
		p	0.00	0.00	0.02	0.02	0.26	0.17	0.00	0.00	0.00	0.00	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	Without outliers (IQR)	r	0.1877***	0.3045***	0.0898	0.0898	0.0653	0.0278	0.1274*	0.2853***	0.2756***	0.3297***	1.00***	1.00***		
		p	0.00	0.00	0.16	0.16	0.31	0.67	0.05	0.00	0.00	0.00	0.00	0.00		
		n	249	249	246	246	246	246	246	250	250	250	250	250		
	Without outliers (mean)	r	0.2033**	0.3098***	0.084	0.084	0.0095	-0.0157	0.102	0.3414***	0.3098***	0.3735***	1.00***	1.00***		
		p	0.00	0.00	0.20	0.20	0.88	0.81	0.12	0.00	0.00	0.00	0.00	0.00		
		n	239	239	236	236	236	236	236	240	240	240	240	240		
	Protein (g/d)	r	0.1096*	0.1993**	0.1753**	0.1753**	0.0427	0.1245*	0.2284***	0.2096***	0.2907***	0.2254***	0.7788***	0.7788***		
		p	0.08	0.00	0.01	0.01	0.50	0.05	0.00	0.00	0.00	0.00	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	Fat (g/d)	r	0.1078*	0.2529***	0.1272**	0.1272**	-0.0359	0.0384	0.0767	0.2894***	0.3142***	0.2879***	0.7496***	0.7496***		
		p	0.09	0.00	0.04	0.04	0.57	0.55	0.23	0.00	0.00	0.00	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	Carbohydrate (g/d)	r	0.1738**	0.2133***	0.1123*	0.1123*	0.1170*	0.0873	0.1766**	0.2162**	0.1655**	0.2906***	0.9310***	0.9310***		
		p	0.01	0.00	0.08	0.08	0.06	0.17	0.01	0.00	0.01	0.00	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	VA (mcg/d)	r	0.0479	0.1586**	0.0633	0.0633	0.1254*	0.0441	0.1144*	0.2181***	0.1874***	0.2761***	0.3722***	0.3722***		
		p	0.45	0.01	0.32	0.32	0.05	0.49	0.07	0.00	0.00	0.00	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	Zinc (mg/d)	r	0.0795	0.1309**	0.1566**	0.1566**	0.0296	0.1154*	0.2135***	0.1150*	0.1968***	0.1423**	0.7433***	0.7433***		
		p	0.21	0.04	0.01	0.01	0.64	0.07	0.00	0.07	0.00	0.02	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	Iron (mg/d)	r	0.0478	0.103	0.1301**	0.1301**	0.0346	0.103	0.2093***	0.1176*	0.1844***	0.1499**	0.7545***	0.7545***		
		p	0.45	0.10	0.04	0.04	0.59	0.11	0.00	0.06	0.00	0.02	0.00	0.00		
		n	254	254	251	251	251	251	251	255	255	255	255	255		
	WAZ	r	0.1322*	0.1540**	0.2022***	0.2022***	-0.0079	0.105	0.1332*	0.0009	0.0989	0.0178	0.064	0.064	0.3345***	1
		p	0.05	0.02	0.00	0.00	0.91	0.12	0.05	0.99	0.15	0.80	0.37	0.37	0.00	
		n	224	224	221	221	221	221	221	210	210	210	200	200	221	225
	HAZ	r	0.107	0.0816	0.0858	0.0858	-0.0491	0.0547	0.0491	-0.0387	0.0715	-0.0177	0.1515**	0.1515**	-0.1677*	0.7900***
		p	0.12	0.24	0.21	0.21	0.48	0.43	0.48	0.59	0.31	0.80	0.04	0.04	0.01	0.00
		n	214	214	211	211	211	211	211	201	201	201	191	191	215	215
	WHZ	r	0.0794	0.1266*	0.1580**	0.1580**	0.0705	0.0948	0.0768	0.0771	0.0812	0.0497	-0.0933	-0.0933	0.9139***	0.6053***
		p	0.25	0.07	0.02	0.02	0.31	0.17	0.27	0.28	0.25	0.49	0.20	0.20	0.00	0.00
		n	212	212	209	209	209	209	209	199	199	199	190	190	213	213

DDS, dietary diversity score; FVS, food variety score; d, day; VA, vitamin A; MDD, minimum dietary diversity; BMI, body mass index; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score; IQR, interquartile range;
**p<0.1, **p<0.05, ***p<0.01*

3 Measuring the double burden of malnutrition – Evidence from rural Kenya

Abstract

Coexistence of overweight/obesity, undernutrition, underweight and/or micronutrient deficiency, often referred to as double burden of malnutrition, is increasingly recognized. However, indicators of undernutrition used differ between articles, making comparison difficult. At the same time, research of double burden of malnutrition focused predominately on urban areas, but rural areas are also affected by the upward trend of overweight and obesity. The objective of this article is to identify and analyze the double burden of malnutrition within individuals (male and female adults, and children <5 years) and households in rural Kenya, using different definitions of undernutrition. In total, we identify seven different double burden definitions. The first two show the coexistence of overweight/obese and micronutrient deficiency of adults and children. Definition three to seven, are defined as an overweight/obese adult and underweight, stunted, wasted or micronutrient deficient child. Data from a cross-sectional survey in Nyanza region in 2016 were used to calculate double burden. A total of 874 adults, 184 children, and 173 households (adult-child pairs) were used in the calculations. Coexistence of micronutrient deficiency and overweight/obesity is found in 19% and 10% of adults and children, respectively. Prevalence is higher for male compared to female adults. Double burden at the household level is observed in all applied definitions, magnitude varies between 1% and 17%. The magnitude of the double burden depends much on how the coexistence is defined and comparison across surveys needs to be done with caution. Our data point out that double burden also exists in rural areas within households, female and male adults, and children <5 years.

Keywords: Double burden, underweight, micronutrient deficiency, overweight, adults and children, rural Kenya

3.1 Introduction

Underweight, micronutrient deficiencies and overweight/obesity are contributing factors to the multiple burdens of malnutrition globally. Still, one out of for children <5 years is affected by chronic malnutrition and globally, 2 billion people suffer from micronutrient deficiencies (FAO et al., 2017; IFPRI, 2017). At the same time, an immense upward trend in the prevalence of overweight and obesity in adults and children can be recognized worldwide (Caballero, 2005; FAO et al., 2017; Popkin et al., 2012; WHO, 2017). Especially, low- and middle-income countries experience simultaneously high rates of child undernutrition together with adult obesity and reflect the complexity and coexistence of multiple forms of malnutrition. Kenya in particular reports an increase in the share of overweight and obesity within children, and women. Over 30% of women in reproductive age are overweight or obese. At the same time, the rates of undernutrition, especially of children and in rural areas, remain persistent and a public health concern (KNBS, 2015; Masibo and Makoka, 2012).

This occurrence of undernutrition along with overweight and obesity is often referred to as double burden of malnutrition (DB) (WHO, 2017). The existence of DB as underweight and overweight/obesity, at population level as well as at household level, is shown in the literature (Doak et al., 2005; Hanandita and Tampubolon, 2015; Roemling and Qaim, 2013). In that context, particularly the existence of DB among mother and child pairs of a household were of interest to other researchers. Identified prevalence of DB varies between lower than 5% in sub-Saharan Africa and 30% Malaysia (Ihab et al., 2013; Wojcicki, 2014). Recent findings by Kimani-Murage et al. (2015) display a prevalence rate as high as 43% among poor urban households in Nairobi, Kenya. An adult or mother is classified as overweight via a body mass index (BMI) that exceeds 25.0 kg/m² (WHO, 2018a). However, the classification of underweight of children differs. Indicators used are weight-for-age Z-scores (WAZ) (Ihab et al., 2013; Saibul et al., 2009), height-for-age Z-scores (HAZ) (Dieffenbach and Stein, 2012; Garrett and Ruel, 2005; Kimani-Murage et al., 2015), BMI-for-age Z-score (BAZ) (Roemling and Qaim, 2013), adult BMI classification (Doak et al., 2005) or combinations of WAZ and HAZ or WAZ/HAZ and weight-for-height Z-score (WHZ) (Jehn and Brewis, 2009; Wibowo et al., 2015). Hence, it remains unclear whether the results across regions show real differences or if they are the results of different definitions.

Undernutrition can not only be described through underweight as an indicator, but also by micronutrient deficiency. At household level, this DB would identify an overweight/obese household member and a micronutrient deficient member. This particular definition of DB can also exist within a single individual, suffering from overweight/obesity and micronutrient deficiencies at the same time. Currently, the literature covering this definition of DB is scarce. So far, research describes the existence of overweight alongside with anemia or zinc deficiencies in school-aged children, adolescents and women of reproductive age in Ecuador, Vietnam, sub-Saharan Africa and middle and high income countries (Freire et al., 2014; Hutchinson, 2016; Jones et al., 2016; Laillou et al., 2014). Prevalence of the coexistence of a micronutrient deficient child and an overweight/obese mother is shown in Ecuadorian families (Freire et al., 2014), but to our knowledge not in the rural African setting. Yet, rural areas are also influenced by migration and changes in diet due to various reasons. Specifically, we are looking into rural Kenya, where a high presence of malnutrition exists. Almost 30% and 4% of children <5 years are affected by chronic and acute malnutrition, 19% of women are overweight and 7% obese (KNBS, 2015).

The overall objective of this article is therefore to identify the nature of the DB with different measures of undernutrition and at different levels. First, the prevalence of DB will be assessed at individual level in male and female adults, and children <5 years, using micronutrient deficiency as indicators of undernutrition. Second, we will identify DB at household level, using different measures of undernutrition (underweight, stunting, wasting and micronutrient deficiency). Since differentiated measures of undernutrition for the assessment of DB are scarce and were never combined in one study, we highly contribute to the literature. A further novelty of this study is the analysis of DB in rural areas, which was limited to urban areas so far.

3.2 Material and methods

3.2.1 Study context and data

The data used were collected in a comprehensive survey of rural, smallholder farm households in the Nyanza region in Western Kenya in 2016. More specifically, the survey was administered in the counties Kisii and Nyamira, where most households are involved in subsistence-oriented farming activities (Mbuvi et al., 2013).

Even though the nutritional status of children in Kenya has improved over the last decades, the prevalence of undernutrition remains high, especially in rural areas (KNBS, 2015; Masibo and Makoka, 2012)[2]. In 2015, according to official statistics, 23% of children <5 years were stunted and 7% were wasted in the Nyanza region. More precisely, 26% of children were stunted in each county, 2% and 4% were wasted in Kisii and Nyamira County, respectively. At the same time, 4% of children <5 years were obese (WHZ Z-score above +2 SD), and almost 30% of females were classified as overweight and obese in Kisii and Nyamira County (KNBS, 2015).

A two-stage sampling procedure was applied to randomly select households for the interview-based survey. First, 48 farmer groups were randomly selected, with a probability proportionate to the total number of farmer groups per County (48 groups in Kisii and 16 in Nyamira). Second, about 20 households were randomly selected from each group based on updated group lists. In total, 835 households were selected. A trained team of interviewers carried out the interviews in the local language using structured questionnaires. Additional to the obtained household data, a male and female adult, and one child aged 6-59 months were targeted in each home to capture individual level food intake and anthropometric data.

In total, eligible data of 764 households and 1,058 individuals (558 female and 316 male adults (16-85 years), and 184 children <5 years) were collected in the survey, as individual data of all three household members was not always possible to obtain.

In the current article, we investigate the existence of DB in rural households. Therefore, we restrict our dataset to a household-sample, where eligible information of a child and at least one adult member exists. Hence, we include data of 173 households, which include information of 173 children, 164 female and 81 male adult individuals. Complete information of two adult members exist in 72 of the households.

3.2.2 Measuring nutritional status

Weight and height measures were taken from all individuals, following recommended techniques (Cogill B, 2003; de Onis et al., 2004). Height from all children younger than 24 months was taken lying down by using a portable infantometer (seca 417 Height Measuring Board), whereas standing height was taken from all other individuals using the seca stadiometer 217. Weight was

[2] Trends of stunting and underweight in rural areas and Nyanza region in Kenya from 1993 to 2015: HAZ (< -2 SD): Rural 41.4% - 29.1%. Nyanza 39.5% - 22.7%; WAZ (< -2 SD): Rural 19.8% - 12.9%. Nyanza 17.2% – 7.4% (KNBS, 2015; Masibo and Makoka, 2012)

measured using a normal weighing scale. To take the weight from younger children, first the weight from the caretaker and afterwards from the caretaker together with the child was taken. Childs weight was then calculated by subtracting the two values. All measures were taken twice and the mean of both measures was used for further calculations. Mean measures of adult's weight and height were used to calculate the body mass index (BMI = body weight in kg/body height in meters squared). Categorization into over- and underweight are applied as proposed by the WHO (WHO, 2006). To assess the nutritional status of children, weight, height and age were used to calculate length/height-for-age Z-scores (HAZ), weight-for-length/height Z-score (WHZ), weight-for-age Z-score (WAZ) and body-mass-index-for-age Z-score (BAZ) by using the WHO growth standard reference from 2006 (WHO Multicentre Growth Reference Study Group, 2006). A child's Z-score is calculated by subtracting the median value of the reference population from the observed value, dividing by the standard deviation (SD) of the reference population. Standardized cut-off points are used to express undernourishment of each indicator. Extreme, moderate and mild undernourishment are defined using the cut-off of -3 SD, -2 SD and -1 SD, respectively (WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006). The cut-off of -2 SD is used to define the three standard indicators for childhood undernutrition: stunting, wasting and underweight. Poor linear growth is reflected in a low HAZ (< -2 SD), also termed stunted, determined by a chronic shortage of adequate quantity and quality of food intake. Acute starvation or moderate wasting is associated with a WHZ below -2 SD. The same indicator is used to express overweight in children (WHZ > +1 SD). As a more unspecific measure of underweight, the WAZ reflects the body mass relative to the chronological age. Additionally, weight divided by squared length/height results in the BAZ, which is likewise considered a reasonable indicator not only to identify underweight, but also overweight (Mei and Grummer-Strawn, 2007; O'Donnell et al., 2008; WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006).

Implausible data, too high as well as too low (22 data sets), were flagged and excluded, using the proposed cut-off points of -/+6 SD for WAZ and -/+5 SD for WHZ and HAZ (Mei and Grummer-Strawn, 2007; WHO Multicentre Growth Reference Study Group, 2006).

3.2.3 Measuring micronutrient deficiency

Another way to determine undernutrition is the inadequate intake of micronutrients. Deficiencies of vitamin A, zinc, and iron make up the largest share of health problems caused by micronutrient malnutrition in developing countries (FAO et al., 2017; Lim et al., 2012). Therefore, we calculate the intake of vitamin A, zinc, and iron from individual consumption data. Food intake was captured using 24 hour dietary recalls, which were answered twice by the adults and once for the child from his or her caretaker. Consumed quantities of all food items were converted into micronutrients using the Tanzanian food composition table (Lukmanji et al., 2008). For a few missing food items values of micronutrients were used from other food composition tables (Hotz et al., 2012; Sehmi, 1993; Stadlmayr et al., 2012; USDA, 2017). Dietary recalls were administered on two different days and untypical days (e.g. celebration or funeral days) were not taken into consideration for the calculation.

To identify a deficient micronutrient intake, we use estimated average requirements (EAR) for each nutrient, which take gender and age into consideration (IOM, 2006). Thus, we define an individual as micronutrient deficient, if the mean intake of at least one of the three micronutrients is below the individual EAR. Table A3.1 in the Appendix displays the used EAR thresholds to define micronutrient deficiency in the current analysis.

3.2.4 Defining double burden of malnutrition

To display the evidence of DB in rural Kenya, we apply seven different definitions of the occurrence, which are displayed in Table 3.1.

The first two DB definitions are applied at the individual-sample (adult and child <5y), using micronutrient deficiency to reflect undernutrition alongside with overweight/obesity. Overweight is defined via BMI cut-off ≥25.0 kg/m² for adults. In the case of children, two different Z-scores are used to define overweight, the BAZ and the WHZ using the cut-off value of >+1 SD (Mei and Grummer-Strawn, 2007; WHO, 2018a, 2018b; WHO Multicentre Growth Reference Study Group, 2006).

Definitions DB 3 - DB 7, display double burden of malnutrition at household level. More specifically, we are interested in the following scenario: a child being affected by undernutrition plus an adult by overweight/obesity (BMI ≥25.0 kg/m²), as children are most vulnerable to

dietary changes. In the case of undernutrition, we use the existence of underweight in children within definition DB 3 – DB 6. We use the aforementioned four calculated Z-scores (BAZ, WAZ, HAZ and WHZ) with the cut-off -2 SD to define a child as underweight, stunted and wasted (Mei and Grummer-Strawn, 2007; WHO, 2018b; WHO Multicentre Growth Reference Study Group, 2006). In the last scenario, we look into a child being micronutrient deficient and an adult-member being overweight/obese (DB 7).

The data of the current article were analyzed with the software package Stata 15.0. We display the existence of double burden using descriptive statistics. We use t-statistics to compare the means of affected and non-affected individuals and households to identify mean difference between both groups. Additionally, as a robustness check, we apply a regression module. As our outcome is a binary variable, we apply a probit-regression model.

Table 3.1 Definitions used to define the double burden of malnutrition (DB) at individual and household-level

DB	Definition
Individual-sample [a]	
DB 1	=1, if adult is micronutrient deficient and overweight (BMI ≥25.0 kg/m²)
DB 2	=1, if child is micronutrient deficient and overweight (BAZ >+ 1 SD)
DB 2.1	=1, if child is micronutrient deficient and overweight (WHZ >+ 1 SD)
Household-sample [b]	
DB 3	=1, if child underweight (BAZ <-2 SD) and adult overweight (BMI ≥25.0 kg/m²)
DB 4	=1, if child underweight (WAZ <-2 SD) and adult overweight (BMI ≥25.0 kg/m²)
DB 5	=1, if child stunted (HAZ <-2 SD) and adult overweight (BMI ≥25.0 kg/m²)
DB 6	=1, if child wasted (WHZ <-2 SD) and adult overweight (BMI ≥25.0 kg/m²)
DB 7	=1, if child is micronutrient deficient and adult overweight (BMI ≥25.0 kg/m²)

DB, double burden of malnutrition; BMI, body mass index; BAZ, body mass index-for-age Z-score; WHZ, weight-for-height Z-score; WAZ, weight-for height Z-score; HAZ, height-for-age Z-score
Note: [a] Individual-sample: adult n = 874 (female n = 558, male n = 316), child n = 184. [b] Household-sample defined as child plus at least one adult existent (household n = 173).

3.3 Results

3.3.1 Individual-sample statistics

Nutritional status

Mean BMI of adults is 25.22 kg/m², with a prevalence of 46% of them being overweight or obese. Figure 3.1, panel A shows the existence of overweight and obesity of adults by gender. Only 8% of males are obese compared to 21% of females (BMI >30.0 kg/m²). Still, 5% of adults have a BMI <18.5 kg/m² and therefore, are classified as underweight.

According to BAZ and WAZ >+1 SD, 28% and 22% of children <5 years are classified as being overweight (Figure 3.1, panel B). Nevertheless, 23% of children are stunted. The prevalence of stunting is slightly lower among girls compared to boys, 21% and 24%, respectively. Ten percent of children are severely stunted (HAZ < -3 SD). Yet, only 1% suffer from acute malnutrition (WHZ < -2 SD). According to BAZ and WAZ, 1% and 7% of children are underweight, respectively (Figure 3.1, panel C). More information on the nutritional status of adults and children is displayed in Table A3.2 in the appendix.

Micronutrient deficiency

About 41% of the adults display a deficient intake in at least one of the three micronutrients. A higher number of the male adults cannot meet their required intake of micronutrients compared to females. Figure 3.1 panel D shows the existence of micronutrient deficiency of adults and children, disaggregated by gender. Thirty-five percent of adults are not meeting the required intake of zinc. Vitamin A and iron deficient are 11% and 2%, respectively.

From 184 children in the sample, 30% are undernourished and display a micronutrient deficiency. Slightly more female children are deficient compared to male children. Twenty-one percent and 29% of girls and boys are zinc deficient. Detailed prevalence of micronutrient deficiencies for adults and children are shown in Appendix Table A3.3.

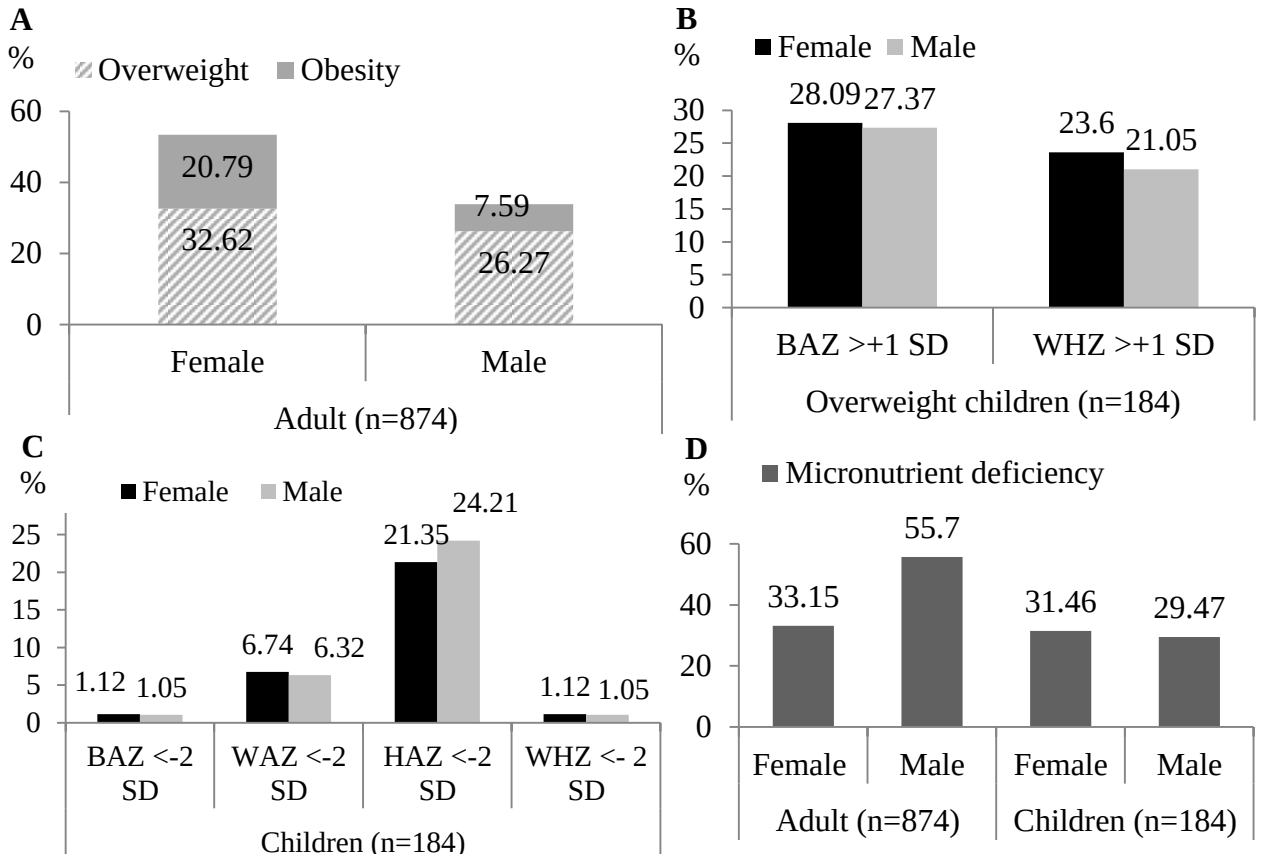

Figure 3.1 Prevalence of overweight and obesity among adults (A). Prevalence of overweight (BAZ > +1 SD and WHZ > +1 SD) of children <5y (B). Existence of underweight (BAZ, WAZ), stunting and wasting of children <5 y (C). Existence of micronutrient deficiencies among adult and children (D).
(BAZ, body mass index-for-age; WHZ, weight-for-height Z-score; y, years; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score)

Double burden of malnutrition within individuals

Figure 3.2 shows the prevalence of existence of DB 1 in adults, female and male, and DB 2 and DB 2.1 children by gender. Coexistence of micronutrient deficiency alongside with overweight/obesity is found in 19% of the adults, according to DB 1. Gender disaggregated, 21% of male and 18% female adults are affected. Table 3.2 shows selected descriptive statistics of the total adult-sample and the sample affected by DB 1. More statistics can be found in the appendix Table A3.4 and Table A3.5. Adults affected by DB are significantly older compared to the non-affected according to t-statistics.

Fewer children are affected by the coexistence of micronutrient deficiency and overweight/obese at individual level compared to the adult-sample. Ten percent and 8% of children are affected by DB 2 and DB 2.1, respectively. According to definition DB 2, 8% and 12% of male and female children are affected. Numbers are slightly lower in DB 2.1 for male

and female children (5% and 11%, see appendix Table A3.6 - Table A3.8). Table 3.3 shows selected descriptive statistics, no significant differences in mean household characteristics between the affected and non-affected children are observed.

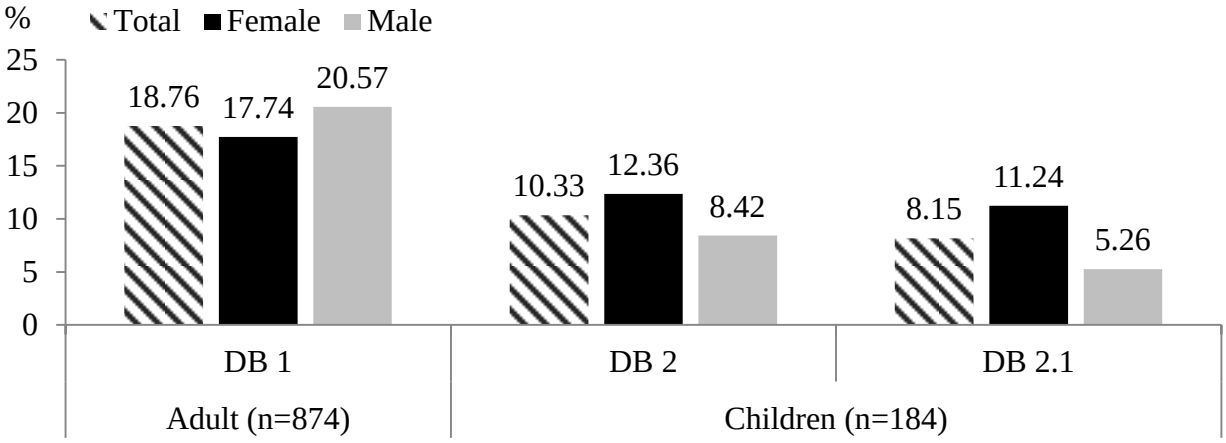

Figure 3.2 Prevalence of double burden of malnutrition of female and male adults (DB1), and children <5 years, by gender (DB 2, DB 2.1)
Note: Sample size of female adults (n=558). Sample size of male adults (n=316). Sample size of female children (n=89). Sample size of male children (n=95). DB 1 adult overweight/obese (BMI ≥25.0 kg/m²) and micronutrient deficient. DB 2 children <5 years overweight (BAZ >+1 SD) and micronutrient deficient. DB 2.1 children <5 years overweight (WHZ >+1 SD) and micronutrient deficient.
(DB, double burden of malnutrition)

Table 3.2 Descriptive statistics of adults (total), non-affected and DB-affected adults (DB 1)

	Adults (n=874)	Non-DB 1 (n=)	DB 1 (n=164)
Household Characteristics			
Kisii county (1/0)	0.69 (0.46)	0.66 (0.47)	0.79*** (0.41)
Male household head (1/0)	0.84 (0.37)	0.83 (0.37)	0.84 (0.37)
Number adults (count)	3.45 (1.50)	1.65 (1.27)	3.72** (1.53)
Number children (count)	1.61 (1.30)	3.39 (1.49)	1.45* (1.38)
Household health[a] (1/0)	0.13 (0.37)	0.12 (0.34)	0.21*** (0.49)
Total income (1,000 Ksh)	278.28 (866.87)	285.69 (947.83)	246.20 (340.25)
Adult Characteristics			
Male adult (1/0)	0.36 (0.48)	0.35 (0.48)	0.40 (0.49)
Age (years)	46.15 (12.94)	45.60 (12.97)	48.54*** (12.58)
Education (years)	8.67 (3.52)	8.69 (3.55)	8.58 (3.35)
Body mass index (kg/m²)	25.22 (5.20)	24.38 (5.21)	28.91*** (3.10)
Dietary diversity (12 FG)	6.46 (0.97)	6.48 (0.96)	6.35 (0.99)

DB, double burden of malnutrition; FG, food groups
Note: Values are means with SD in parentheses. DB 1 adult overweight and micronutrient deficient;
[a] household health =1 if a member with chronic disease exists within the household.
*Difference between adults affected by DB 1 and non-affected is significant at 10% level.
**Difference between adults affected by DB 1 and non-affected is significant at 5% level.
***Difference between adults affected by DB 1 and non-affected is significant at 1% level.

Table 3.3 Descriptive statistics of children (total), non-affected and DB-affected children (DB 2 and DB 2.1)

	Children (n=184)	Non-DB 2 (n=165)	DB 2 (n=19)	Non-DB 2.1 (n=169)	DB 2.1 (n=15)
Household characteristics					
Kisii county (1/0)	0.69 (0.46)	0.67 (0.47)	0.89** (0.32)	0.66 (0.47)	1.00*** (0.00)
Male household head (1/0)	0.81 (0.39)	0.80 (0.40)	0.89 (0.32)	0.81 (0.39)	0.80 (0.41)
Number adults (count)	3.38 (1.47)	2.52 (1.19)	3.05 (1.47)	2.52 (1.19)	3.53 (1.55)
Number children (count)	2.51 (1.16)	3.41 (1.47)	2.42 (0.90)	3.36 (1.47)	2.40 (0.91)
Household health[a] (1/0)	0.08 (0.30)	0.08 (0.32)	0.00 (0.00)	0.08 (0.32)	0.00 (0.00)
Total income (1,000 Ksh)	310.87 (836.70)	317.58 (880.33)	252.61 (228.62)	317.36 (871.13)	237.80 (195.54)
Child variables					
Male child (1/0)	0.52 (0.50)	0.53 (0.50)	0.42 (0.51)	0.53 (0.50)	0.33 (0.49)
Age (months)	35.47 (12.69)	35.55 (12.32)	34.79 (15.91)	35.95 (12.36)	30.13* (15.39)
Dietary diversity (12 FG)	6.74 (1.11)	6.78 (1.09)	6.42 (1.26)	6.78 (1.10)	6.40 (1.18)
Minimum dietary diversity (7 FG)	4.13 (0.93)	4.18 (0.92)	3.74* (0.99)	4.18 (0.93)	3.60** (0.74)

DB, Double burden of malnutrition; FG, food group

Note: Values are means with SD in parentheses. Statistics of non-affected household can be found in Appendix Table A3.9 and Table A3.10. DB 2 child overweight (BMIZ >+1SD) and micronutrient deficient. DB 2.1 overweight (WHZ >+1SD) and micronutrient deficiency.

[a] household health =1 if a member with chronic disease exists within the household.

*Difference between children affected by DB 2/DB 2.1 and non- affected is significant at 10% level.

**Difference between adults affected by DB 2/DB 2.1and non-affected is significant at 5% level.

***Difference between adults affected by DB 2/DB 2.1and non-affected is significant at 1% level

3.3.2 Double burden of malnutrition at the household

The coexistence of an overweight/obese adult and undernourished child (<5 years) was found in all applied double burden definitions in Kisii and Nyamira County. However, the magnitude varies between definitions as seen in Figure 3.3. Only one household is affected when applying the definition DB 3 and DB 6, which take BAZ and WHZ measures of children into account. In 13% of households, an overweight/obese adult coexists with a stunted child (DB 5). Moreover, the coexistence of an overweight or obese adult and a micronutrient deficient child was found in 17% of the households (DB 7). Selected numbers that show different DB definitions at the households are presented in Table 3.4. Further variables are presented in the appendix Table A3.9 and Table A3.10. No significant differences between the particular double burden groups can be found for the different household characteristics according to the t-statistics.

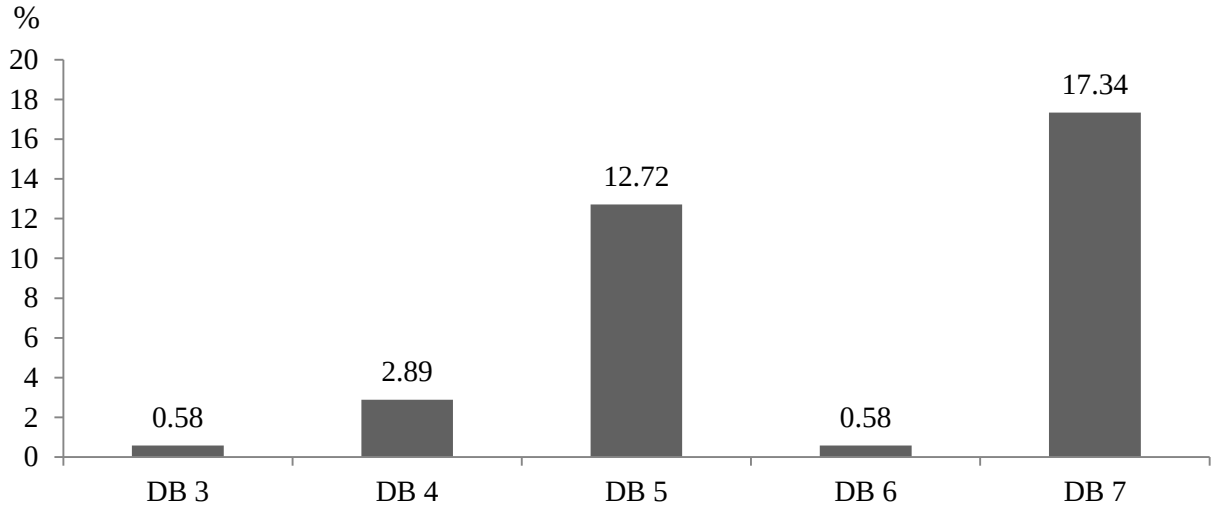

Figure 3.3 Existence of double burden at the household-sample in percent (DB 3 – DB 7).
Note: All definitions include adult overweight (BMI ≥25.0) and differ in classification of undernutrition of children as follows: DB 3 child underweight (BAZ <-2 SD), DB 4 child underweight (WAZ <-2 SD), DB 5 child stunting (HAZ <-2 SD), DB 6 child wasting (WHZ <-2 SD), DB 7 child micronutrient deficient.
(DB, double burden of malnutrition)

Table 3.4 Descriptive statistics for households affected by the different double burden definitions (DB 3, DB 4, DB 5, DB 6, and DB 7)

	Total (n=173)	DB 3 (n=1)	DB 4 (n=5)	DB 5 (n=22)	DB 6 (n=1)	DB 7 (n=30)
Kisii county (1/0)	0.69 (0.46)	1.00 (.)	0.80 (0.45)	0.68 (0.48)	1.00 (.)	0.83* (0.38)
Male household head (1/0)	0.83 (0.37)	0.00 (.)	0.40*** (0.55)	0.77 (0.43)	0.00 (.)	0.83 (0.38)
Age household head (years)	46.41 (11.86)	66.00 (.)	47.80 (14.08)	45.64 (13.07)	66.00 (.)	50.80** (11.65)
Education household head (years)	9.32 (3.38)	2.00 (.)	6.40** (2.51)	8.50 (3.49)	2.00 (.)	8.37* (3.68)
Number adults (count)	3.35 (1.46)	6.00 (.)	4.60* (1.67)	3.59 (1.47)	6.00 (.)	3.60 (1.30)
Number children (count)	2.50 (1.15)	3.00 (.)	2.60 (1.14)	2.91* (0.97)	3.00 (.)	1.97*** (1.00)
Household health[a] (1/0)	0.08 (0.31)	0.00 (.)	0.20 (0.45)	0.09 (0.29)	0.00 (.)	0.07 (0.37)
Dietary diversity (12 FG)	6.38 (0.89)	5.00 (.)	6.00 (0.71)	6.50 (0.86)	5.00 (.)	6.10* (0.88)
Male child (1/0)	0.52 (0.50)	1.00 (.)	0.60 (0.55)	0.55 (0.51)	1.00 (.)	0.47 (0.51)
Age child (months)	35.91 (12.44)	59.00 (.)	45.00* (16.20)	40.27* (13.28)	59.00 (.)	40.10** (14.99)

DB, double burden of malnutrition; FG, food group

Note: Values are means with SD in parentheses. Descriptive of non-affected households are found in Table A3.9 and Table A3.10. All definitions include adult overweight (BMI ≥25.0) and differ in classification of undernutrition of children as follows: DB 3 child underweight (BAZ < -2 SD), DB 4 child underweight (WAZ < -2 SD), DB 5 child stunting (HAZ < -2 SD), DB 6 child wasting (WHZ < -2 SD), DB 7 child micronutrient deficient.

[a] household health =1 if a member with chronic disease exists within the household.

*Difference between households affected by DB and non-affected is significant at 10% level.

**Difference between households affected by DB and non-affected is significant at 5% level.

***Difference between households affected by DB and non-affected is significant at 1% level.

3.4 Discussion

Multiple forms of malnutrition exist. One factor, which contributes to the complexity, is the concurrent occurrence of underweight, micronutrient deficiency, and overweight/obesity within households and individuals. This article focuses on measurement issues of DB. Therefore, we define seven different combinations of indicators to depict DB. We find evidence that DB exists in rural areas of Nyanza region, Kenya, regardless which definition of DB is applied.

First, we looked into the existence of DB at individual level (DB 1 and DB 2/ DB 2.1). The consumptions of essential amount of nutrients are central to grow adequately, stay healthy and to deliver performance to society, which is not only important for children, but for each individual. We found that 19% of adult individuals, 10% and 8% of children <5 years are affected by micronutrient deficiency and overweight/obesity simultaneously. This evidence shows that overweight and obesity are present in rural areas, and that micronutrient deficiency is a concern. Literature, that uses specific micronutrient deficiency as an indicator, support our findings for children and female adults (Freire et al., 2014; Hutchinson, 2016; Jones et al., 2016; Laillou et al., 2014). We additionally show evidence that 21% of the male adults are affected by DB, which is noteworthy as male adults have not been in the focus yet. This evidence displays the complexity and the importance to understand the phenomenon for each individual worldwide. Micronutrient deficiencies are calculated via food intake of adults and children in this article, which differs to other articles looking into DB, which assessed one specific micronutrient deficiency via blood-measures (Freire et al., 2014; Hutchinson, 2016; Jones et al., 2016; Laillou et al., 2014). Use of biochemical data may be more precise, however the information derived from biochemical measurements is cost intensive, nutrient specific, and invasive (Nelson et al., 2004). Hence, they are only used for very specific purposes. Micronutrient deficiency can be monitored by the use of intake data. Dietary intake via recall is widely used to assess energy, macro- and micronutrient intake, as it is more cost-efficient.

Second, we show evidence of DB at household level, where we used five different indicators to describe undernutrition. Previous studies only use one indicator of undernutrition, which makes the cross-comparison complex. Our data show evidence of DB, regardless which undernutrition indicator is applied. The magnitude varies between 1% and 17% (DB 3/ DB 6 and DB 7).

According to the literature, the most common indicator to display undernutrition of children was stunting (Dieffenbach and Stein, 2012; Garrett and Ruel, 2005; Kimani-Murage et al., 2015). Stunting is associated with growth gradation, which is linked with a chronic suboptimal supply of essential nutrients and poor development. Zinc deficiency is negatively associated with the growth of children (Black et al., 2013). This provides us with an argument to use stunting as an indicator, instead of micronutrient deficiency. We found out that 13% of households are affected when applying this definition (DB 5). Micronutrient deficiencies were found in 41% of adults and 30% of children, insufficient intake of zinc being the driver of micronutrient deficiency in our sample. Given the high prevalence of micronutrient malnutrition, the coexistence of an overweight/obese adult and a micronutrient deficient child might be more sufficient to display DB. We found the highest prevalence with this definition of DB (DB 7; 17%) compared to the other DB definitions. This evidence was only shown in Ecuadorian households so far (Freire et al., 2014), and to our knowledge this is the first study analyzing DB in rural Africa. Evidence of deficit and excess in the same household, highlight that only the provision of food is not the solution. Quality of food and the knowledge of preparation to address underlying factors is the important factor (Garrett and Ruel, 2005). Due to the small sample size, regression results only show the direction, but cannot be interpreted in any way (see Appendix Table A3.11).

Up to know, DB was found and described as an urban challenge. As key contributor to DB, researchers identified nutrition transition, which is characterized as shift and changes in diets and lifestyle patterns and linked to a more sedentary occupation, higher income, consumption of higher energy-dense food intake. This leads to a positive energy balance, and therefore is a driving factor of the rise in overweight of adults (Caballero, 2005; Dieffenbach and Stein, 2012; Doak et al., 2005; Jehn and Brewis, 2009; Kimani-Murage et al., 2015; Popkin et al., 2012). The existence of evidence in rural areas leads to new and different challenges.

Our data point out that double burden exists in rural areas, but the magnitude of the problem depends on how the coexistence is defined and measured. Therefore, comparisons across surveys need to be made with caution. Further, research on the identification of drivers in rural areas is highly needed. Additionally, nutrition and health related policy and program implementations need to take the simultaneous presence of overweight and undernutrition into account while designing nutrition related interventions.

3.5 Appendix A3

Table A3.1 Used estimated average requirements (EAR) for micronutrients

Gender	Age	Iron (mg/d)	Zinc (mg/d)	Vitamin A (µg/d)
Male	19-30y	7.7	9.4	630
	31-50y	6.0	9.4	625
	51-70y	6.0	9.4	625
	>70y	6.0	9.4	625
Female	14-18y	7.9	7.3	485
	19-30y	8.1	6.8	500
	31-50y	8.1	6.8	500
	51-70y	5.0	6.8	500
	>70y	5.0	6.8	500
Child	6-12 m	6.9	2.5	210
	1-3y	3.0	2.5	210
	4-8y	4.1	4.0	275

y, year
Note: estimates average requirements taken from IOM 2006

Individual-sample statistics

Table A3.2 Nutritional status of adults and children by gender at individual level classified by BMI and Z-score

	Total (n=874)		Female (n=558)		Male (n=316)	
	n	%	n	%	N	%
Adult-sample						
Underweight (BMI < 18.5)	43	4.92	21	3.76	22	6.96
Overweight/obese (BMI ≥ 25.0)	405	46.32	298	53.41	107	33.86
Overweight (BMI ≥ 25.0 and < 30.0)	265	30.32	182	32.62	83	26.27
Obesity (BMI ≥ 30.0)	140	16.02	116	20.79	24	7.59
Child Sample	Total (n=184)		Female (n=89)		Male (n=95)	
Sever underweight (BAZ < -3 SD)	1	0.54	0		1	0.54
Sever underweight (WAZ < -3 SD)	2	1.09	0		2	2.11
Sever stunting (HAZ < -3 SD)	16	8.7	7	7.37	9	10.11
Sever wasting (WHZ < - 3SD)	1	0.54	0		1	0.54
Underweight (BAZ < -2 SD)	2	1.09	1	1.12	1	1.05
Underweight (WAZ < -2 SD)	12	6.52	6	6.74	6	6.32
Stunting (HAZ < -2 SD)	42	22.83	19	21.35	23	24.21
Wasting (WHZ < - 2 SD)	2	1.09	1	1.12	1	1.05
Mild Underweight (BMIZ < -1 SD)	13	7.07	6	6.74	7	7.37
Mild Underweight (WAZ < -1 DS)	51	27.72	24	26.97	27	28.42
Mild stunting (HAZ < -1 DS)	93	50.54	39	43.82	54	65.84
Mild wasting (WHZ < -1 DS)	14	7.61	5	5.62	9	9.47
Overweight (BMIZ > +1SD)	51	27.72	25	28.09	26	27.37
Overweight (WHZ > +1 SD)	41	22.28	21	23.6	20	21.05

n, sample size; BMI, body mass index; BAZ, body mass index-for-age Z-score; WAZ, weight-for-height Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score
Note: Body mass index displayed in kg/m².

Table A3.3 Existence of micronutrient deficiency by different samples and gender

	Micronutrient deficiency		VA deficiency		Zinc deficiency		Iron deficiency	
	n	%	n	%	n	%	n	%
Adults								
Total (n=874)	361	41.3	97	11.09	313	35.77	16	1.83
Female (n=558)	185	33.15	50	8.96	158	28.32	14	2.51
Male (n=316)	176	55.7	47	14.87	155	49.05	2	0.63
Child-sample								
Total (n=184)	56	30.43	15	8.15	47	25.54	17	9.34
Female (n=98)	28	31.46	10	11.24	19	21.35	5	5.75
Male (n=95)	28	29.47	5	5.26	28	29.47	12	12.63

VA, vitamin A

Table A3.4 Descriptive statistics of total adults, non-affected and DB-affected adults (DB 1)

	Total (n=874)	Non-DB 1 (n=710)	DB 1 (n=164)
Household characteristics			
Kisii county (1/0)	0.69 (0.46)	0.66 (0.47)	0.79*** (0.41)
Male HH head (1/0)	0.84 (0.37)	0.83 (0.37)	0.84 (0.37)
Age HH head (years)	50.58 (12.32)	50.10 (12.56)	52.66** (11.04)
Marital status HH head (1/0)	0.83 (0.38)	0.83 (0.38)	0.82 (0.38)
Farming occupation HH head (1/0)	0.64 (0.48)	0.63 (0.48)	0.66 (0.48)
Education HH head (years)	9.05 (3.93)	9.03 (4.01)	9.14 (3.60)
Number adults (count)	3.45 (1.50)	3.39 (1.49)	3.72** (1.53)
Number children (count)	1.61 (1.30)	1.65 (1.27)	1.45* (1.38)
Household health[a] (1/0)	0.13 (0.37)	0.12 (0.34)	0.21*** (0.49)
Protected water source (1/0)	0.65 (0.48)	0.65 (0.48)	0.61 (0.49)
Toilet facility existent (1/0)	0.97 (0.18)	0.97 (0.18)	0.97 (0.17)
Agricultural income (1,000 Ksh)	126.62 (662.76)	128.91 (723.78)	116.71 (271.67)
Total income (1,000 Ksh)	278.28 (866.87)	285.69 (947.83)	246.20 (340.25)
Farm size (acres)	1.29 (1.20)	1.25 (1.11)	1.50** (1.50)
Food purchase (share)	56.27 (13.67)	56.27 (13.37)	56.27 (14.93)
Adult Characteristics			
Male adult (1/0)	0.36 (0.48)	0.35 (0.48)	0.40 (0.49)
Age (years)	46.15 (12.94)	45.60 (12.97)	48.54*** (12.58)
Marital status (1/0)	1.71 (1.43)	1.70 (1.43)	1.73 (1.47)
Education (years)	8.67 (3.52)	8.69 (3.55)	8.58 (3.35)
Body mass index (kg/m^2)	25.22 (5.20)	24.38 (5.21)	28.91*** (3.10)
Dietary diversity (12 FG)	6.46 (0.97)	6.48 (0.96)	6.35 (0.99)
MDD-W[b]	4.93 (0.90)	4.95 (0.90)	4.81* (0.92)
Micronutrient deficiency (1/0)	0.41 (0.49)	0.28 (0.45)	1.00*** (0.00)
VA deficiency (1/0)	0.11 (0.31)	0.08 (0.27)	0.26*** (0.44)
Iron deficiency (1/0)	0.02 (0.13)	0.01 (0.11)	0.05*** (0.22)
Zinc deficiency (1/0)	0.36 (0.48)	0.24 (0.43)	0.88*** (0.33)
Underweight (BMI <18.5 kg/m²) (1/0)	0.05 (0.22)	0.06 (0.24)	0.00*** (0.00)
Overweight/obese (BMI ≥25.0 kg/m²) (1/0)	0.46 (0.50)	0.34 (0.47)	1.00*** (0.00)
Overweight (BMI ≥25.0 kg/m² and <30.0 kg/m²) (1/0)	0.30 (0.46)	0.22 (0.41)	0.67*** (0.47)
Obesity (BMI >30.0 kg/m²) (1/0)	0.16 (0.37)	0.12 (0.33)	0.33*** (0.47)

DB, double burden of malnutrition; HH, household, BMI, body mass index; FG, Food group; MDD-W, minimum dietary diversity for women; VA, vitamin A

Note: Values are means with SD in parentheses. DB 1 adult micronutrient deficient and overweight; [a] household health =1 if a member with chronic disease exists within the household. [b] MDD-W calculated for female and male adults

*Difference between adults affected by DB 1 and non-affected is significant at 10% level. **Difference between adults affected by DB 1 and non-affected is significant at 5% level. ***Difference between adults affected by DB 1 and non-affected is significant at 1% level.

Table A3.5 Descriptive statistics of total female and male adults, non-affected, and DB-affected female and male adults (DB 1)

	Female			Male		
	Total (n=558)	Non-DB 1 (n=459)	DB 1 (n=99)	Total (n=316)	Non-DB 1 (n=251)	DB 1 (n=65)
Household characteristics						
Kisii county (1/0)	0.66 (0.47)	0.65 (0.48)	0.73*** (0.45)	0.72 (0.45)	0.68 (0.47)	0.88*** (0.33)
Male HH head (1/0)	0.75 (0.44)	0.75 (0.43)	0.74 (0.44)	0.99 (0.10)	0.99 (0.11)	1.00 (0.00)
Age HH head (years)	50.34 (12.18)	50.17 (12.46)	51.14** (10.81)	50.99 (12.58)	49.96 (12.76)	54.98*** (11.07)
Marital status HH head (1/0)	0.76 (0.43)	0.76 (0.43)	0.75 (0.44)	0.95 (0.22)	0.95 (0.21)	0.94 (0.24)
Farming occupation HH head (1/0)	0.61 (0.49)	0.60 (0.49)	0.66 (0.48)	0.68 (0.47)	0.69 (0.46)	0.66 (0.48)
Education HH head (years)	8.89 (4.18)	8.88 (4.29)	8.95 (3.64)	9.33 (3.44)	9.30 (3.42)	9.43 (3.53)
Number adults (count)	3.39 (1.49)	3.34 (1.47)	3.64** (1.55)	3.55 (1.52)	3.48 (1.52)	3.85 (1.51)
Number children (count)	1.67 (1.30)	1.70 (1.28)	1.57* (1.39)	1.51 (1.28)	1.57 (1.26)	1.28 (1.34)
Household health [a] (1/0)	0.13 (0.35)	0.12 (0.34)	0.17*** (0.43)	0.15 (0.40)	0.12 (0.34)	0.26*** (0.57)
Protected water source (1/0)	0.63 (0.48)	0.64 (0.48)	0.60 (0.49)	0.66 (0.47)	0.67 (0.47)	0.63 (0.49)
Toilet facility existent (1/0)	0.97 (0.16)	0.97 (0.17)	0.98 (0.14)	0.96 (0.20)	0.96 (0.20)	0.95 (0.21)
Agricultural income (1,000 Ksh)	107.18 (587.76)	109.73 (638.56)	95.40 (240.21)	160.95 (777.57)	163.99 (858.33)	149.18 (312.80)
Total income (1,000 Ksh)	269.21 (894.15)	281.46 (975.69)	212.39 (301.88)	294.30 (817.63)	293.42 (896.50)	297.71 (388.38)
Farm size (acres)	1.19 (1.05)	1.20 (1.05)	1.18** (1.04)	1.47 (1.41)	1.33 (1.21)	1.98*** (1.92)
Food purchase (share)	56.19 (13.71)	56.04 (13.24)	56.89 (15.76)	56.40 (13.61)	56.68 (13.62)	55.33 (13.64)
Adult Characteristics						
Male adult (1/0)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Age (years)	43.70 (12.63)	43.54 (12.80)	44.42*** (11.84)	50.49 (12.36)	49.38 (12.45)	54.80*** (11.07)
Marital status (1/0)	1.97 (1.62)	1.96 (1.61)	2.93 (1.67)	1.24 (0.84)	1.23 (0.81)	1.28 (0.93)
Education (years)	8.29 (3.51)	8.35 (3.59)	8.02 (3.12)	9.34 (3.43)	9.32 (3.41)	9.43 (3.53)
Body mass index (kg/m^2)	26.02 (5.57)	25.33 (5.73)	29.27*** (3.17)	23.82 (4.11)	22.66 (3.52)	28.36*** (2.93)

Dietary diversity (12 FG)	6.44 (0.97)	6.46 (0.96)	6.33 (0.99)	6.50 (0.97)	6.53 (0.96)	6.38 (1.00)
MDD-W [b]	4.89 (0.91)	4.93 (0.90)	4.72* (0.93)	4.99 (0.89)	5.00 (0.89)	4.95 (0.89)
Micronutrient deficiency (1/0)	0.33 (0.47)	0.19 (0.39)	1.00*** (0.00)	0.56 (0.50)	0.44 (0.50)	1.00*** (0.00)
VA deficiency (1/0)	0.09 (0.29)	0.05 (0.22)	0.26*** (0.44)	0.15 (0.36)	0.12 (0.33)	0.26*** (0.44)
Iron deficiency (1/0)	0.03 (0.16)	0.01 (0.11)	0.08*** (0.27)	0.01 (0.08)	0.01 (0.09)	0.00 (0.00)
Zinc deficiency (1/0)	0.28 (0.45)	0.16 (0.36)	0.87*** (0.34)	0.49 (0.50)	0.39 (0.49)	0.89*** (0.31)
Underweight (BMI <18.5 kg/m²) (1/0)	0.04 (0.19)	0.05 (0.21)	0.00*** (0.00)	0.07 (0.25)	0.09 (0.28)	0.00** (0.00)
Overweight/obese (BMI ≥25.0 kg/m²) (1/0)	0.53 (0.50)	0.43 (0.50)	1.00*** (0.00)	0.34 (0.47)	0.17 (0.37)	1.00*** (0.00)
Overweight (BMI ≥25.0 kg/m² and <30.0 kg/m²) (1/0)	0.33 (0.47)	0.26 (0.44)	0.62*** (0.49)	0.26 (0.44)	0.14 (0.34)	0.75*** (0.43)
Obesity (BMI >30.0 kg/m²) (1/0)	0.21 (0.41)	0.17 (0.38)	0.38*** (0.49)	0.08 (0.27)	0.03 (0.18)	0.25*** (0.43)

DB, double burden of malnutrition; HH, household, BMI, body mass index; FG, Food group, MDD-W; minimum dietary diversity for women; VA, vitamin A
Note: Values are means with SD in parentheses. DB 1 adult micronutrient deficient and overweight.
[a] household health =1 if a member with chronic disease exists within the household. [b] MDD-W calculated for female and male adults
*Difference between adults affected by DB 1 and non- affected is significant at 10% level. **Difference between adults affected by DB 1 and non-affected is significant at 5% level. ***Difference between adults affected by DB 1 and non-affected is significant at 1% level

Table A3.6 Descriptive statistics of children (total), non-affected andDB- affected children (DB 2 and DB 2.1)

	Children (n=184)	Non-DB 2 (n=165)	DB 2 (n=19)	Non-DB 2.1 (n=169)	DB 2.1 (n=15)
Household characteristics					
Kisii county (1/0)	0.69 (0.46)	0.67 (0.47)	0.89** (0.32)	0.66 (0.47)	1.00*** (0.00)
Male household head (1/0)	0.81 (0.39)	0.80 (0.40)	0.89 (0.32)	0.81 (0.39)	0.80 (0.41)
Age household head (years)	46.52 (11.67)	46.72 (11.58)	44.79 (12.58)	46.31 (11.66)	48.80 (11.95)
Marital status household head (1/0)	0.82 (0.39)	0.81 (0.39)	0.84 (0.37)	0.82 (0.39)	0.80 (0.41)
Farming occupation household head (1/0)	0.60 (0.49)	0.60 (0.49)	0.63 (0.50)	0.60 (0.49)	0.67 (0.49)
Education household head (years)	9.29 (3.38)	9.30 (3.38)	9.21 (3.43)	9.34 (3.35)	8.73 (3.77)
Number of adults (count)	2.51 (1.16)	2.52 (1.19)	2.42 (0.90)	2.52 (1.19)	2.40 (0.91)
Number of children (count)	3.38 (1.47)	3.41 (1.47)	3.05 (1.47)	3.36 (1.47)	3.53 (1.55)
Household health[a] (1/0)	0.08 (0.30)	0.08 (0.32)	0.00 (0.00)	0.08 (0.32)	0.00 (0.00)
Protected water source (1/0)	0.61 (0.49)	0.61 (0.49)	0.68 (0.48)	0.60 (0.49)	0.80 (0.41)
Toilet facility existent (1/0)	0.97 (0.16)	0.97 (0.17)	1.00 (0.00)	0.97 (0.17)	1.00 (0.00)
Agricultural income (1,000 Ksh)	92.86 (148.52)	92.54 (152.01)	95.63 (117.22)	91.83 (150.67)	104.39 (125.53)
Total income (1,000 Ksh)	310.87 (836.70)	317.58 (880.33)	252.61 (228.62)	317.36 (871.13)	237.80 (195.54)
Farm size (acres)	1.26 (1.17)	1.23 (1.16)	1.58 (1.28)	1.22 (1.15)	1.72 (1.41)
Food purchase (share)	56.54 (13.81)	56.11 (13.74)	60.23 (14.23)	56.35 (13.69)	58.66 (15.39)
Child variables					
Male child (1/0)	0.52 (0.50)	0.53 (0.50)	0.42 (0.51)	0.53 (0.50)	0.33 (0.49)
Age (months)	35.47 (12.69)	35.55 (12.32)	34.79 (15.91)	35.95 (12.36)	30.13* (15.39)
Received breastmilk (1/0)	0.97 (0.18)	0.96 (0.19)	1.00 (0.00)	0.96 (0.19)	1.00 (0.00)
Still breastfed (1/0)	0.13 (0.33)	0.12 (0.33)	0.16 (0.37)	0.12 (0.32)	0.20 (0.41)
Disease suffered within last 14 days (1/0)	0.22 (0.41)	0.22 (0.41)	0.21 (0.42)	0.21 (0.41)	0.27 (0.46)
Dietary diversity (12 FG)	6.74 (1.11)	6.78 (1.09)	6.42 (1.26)	6.78 (1.10)	6.40 (1.18)
Minimum dietary diversity (7 FG)	4.13 (0.93)	4.18 (0.92)	3.74* (0.99)	4.18 (0.93)	3.60** (0.74)
Micronutrient deficiency (1/0)	0.30 (0.46)	0.22 (0.42)	1.00*** (0.00)	0.24 (0.43)	1.00*** (0.00)
VA deficiency (1/0)	0.08 (0.27)	0.07 (0.25)	0.21** (0.42)	0.06 (0.24)	0.33*** (0.49)
Iron deficiency (1/0)	0.09 (0.29)	0.08 (0.27)	0.21* (0.42)	0.08 (0.28)	0.20 (0.41)

Page | 65

Zinc deficiency (1/0)	0.26 (0.44)	0.19 (0.40)	0.79*** (0.42)	0.21 (0.41)	0.73*** (0.46)
Underweight (BAZ <-2 SD) (1/0)	0.01 (0.10)	0.01 (0.11)	0.00 (0.00)	0.01 (0.11)	0.00 (0.00)
Underweight (WAZ <-2 SD) (1/0)	0.07 (0.25)	0.07 (0.26)	0.00 (0.00)	0.07 (0.26)	0.00 (0.00)
Stunting (HAZ <-2 SD) (1/0)	0.23 (0.42)	0.22 (0.42)	0.26 (0.45)	0.23 (0.42)	0.20 (0.41)
Wasting (WHZ <-2 SD) (1/0)	0.01 (0.10)	0.01 (0.11)	0.00 (0.00)	0.01 (0.11)	0.00 (0.00)
Overweight (BAZ >+1 SD)	0.28 (0.45)	0.19 (0.40)	1.00*** (0.00)	0.22 (0.41)	0.93*** (0.26)
Overweight (WHZ >+1SD)	0.22 (0.42)	0.16 (0.37)	0.74*** (0.45)	0.15 (0.36)	1.00*** (0.00)

DB, double burden of malnutrition; FG, food group; BAZ, body mass index-for-age Z-score; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ; weight-for-height Z-score; VA, vitamin A

Note: Values are means with SD in parentheses. DB2 child overweight (BMIZ >+1SD) and micronutrient deficient; DB2.1 overweight (WHZ >+1SD) and micronutrient deficiency.

[a] household health =1 if a member with chronic disease exists within the household.

*Difference between children affected by DB 2/DB 2.1 and non-affected is significant at 10% level. **Difference between children affected by DB 2/DB 2.1 and non-affected is significant at 5% level. ***Difference between children affected by DB 2/DB 2.1 and non-affected is significant at 1% level

Table A3.7 Descriptive statistics of female children (total), non-affected and DB-affected children (DB 2 and DB 2.1)

	Total (n=89)	Non DB 2 (n=78)	DB 2 (n=11)	Non-DB 2.1 (n=79)	DB 2.1 (n=10)
Household characteristics					
Kisii county (1/0)	0.62 (0.49)	0.58 (0.50)	0.58** (0.50)	0.57 (0.50)	1.00*** (0.00)
Male household head (1/0)	0.83 (0.38)	0.83 (0.38)	0.83 (0.38)	0.84 (0.37)	0.80 (0.42)
Age household head (years)	46.35 (12.60)	46.51 (12.49)	46.51 (12.49)	46.32 (12.53)	46.60 (13.87)
Marital status household head (1/0)	0.81 (0.40)	0.82 (0.39)	0.82 (0.39)	0.82 (0.38)	0.70 (0.48)
Farming occupation household head (1/0)	0.61 (0.49)	0.62 (0.49)	0.62 (0.49)	0.61 (0.49)	0.60 (0.52)
Education household head (years)	9.08 (3.19)	8.99 (3.06)	8.99 (3.06)	9.05 (3.09)	9.30 (4.06)
Number of adults (count)	2.45 (1.18)	2.46 (1.20)	2.46 (1.20)	2.46 (1.20)	2.40 (1.07)
Number of children (count)	3.24 (1.45)	3.29 (1.45)	3.29 (1.45)	3.27 (1.47)	3.00 (1.33)
Household health[a] (1/0)	0.09 (0.32)	0.10 (0.35)	0.10 (0.35)	0.10 (0.34)	0.00 (0.00)
Protected water source (1/0)	0.61 (0.49)	0.59 (0.50)	0.59 (0.50)	0.58 (0.50)	0.80 (0.42)
Toilet facility existent (1/0)	0.96 (0.21)	0.95 (0.22)	0.95 (0.22)	0.95 (0.22)	1.00 (0.00)
Agricultural income (1,000 Ksh)	102.77 (172.84)	102.82 (177.17)	102.82 (177.17)	101.62 (176.36)	111.88 (149.78)
Total income (1,000 Ksh)	302.56 (802.93)	307.56 (854.02)	307.56 (854.02)	310.40 (848.90)	240.64 (231.20)

Farm size (acres)	1.29 (1.24)	1.29 (1.25)	1.29 (1.25)	1.28 (1.25)	1.36 (1.27)
Food purchase (share)	56.96 (14.31)	55.94 (13.91)	55.94* (13.91)	56.18 (13.98)	63.12 (16.10)
Child variables					
Male child (1/0)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Age (months)	34.12 (12.86)	34.69 (12.32)	34.69 (12.32)	34.61 (12.27)	30.30 (17.17)
Received breastmilk (1/0)	0.97 (0.18)	0.96 (0.19)	0.96 (0.19)	0.96 (0.19)	1.00 (0.00)
Still breastfed (1/0)	0.18 (0.39)	0.17 (0.38)	0.17 (0.38)	0.16 (0.37)	0.30 (0.48)
Disease suffered within last 14 days (1/0)	0.20 (0.40)	0.19 (0.40)	0.19 (0.40)	0.19 (0.39)	0.30 (0.48)
Dietary diversity (12 FG)	6.87 (1.09)	6.92 (1.09)	6.92 (1.09)	6.91 (1.09)	6.50 (1.08)
Minimum dietary diversity (7 FG)	4.13 (0.87)	4.22 (0.88)	4.22** (0.88)	4.22 (0.87)	3.50** (0.53)
Micronutrient deficiency (1/0)	0.31 (0.47)	0.22 (0.42)	0.22*** (0.42)	0.23 (0.42)	1.00*** (0.00)
VA deficiency (1/0)	0.11 (0.32)	0.08 (0.27)	0.08*** (0.27)	0.08 (0.27)	0.40*** (0.52)
Iron deficiency (1/0)	0.06 (0.23)	0.04 (0.20)	0.04* (0.20)	0.04 (0.19)	0.20 (0.42)
Zinc deficiency (1/0)	0.21 (0.41)	0.15 (0.36)	0.15*** (0.36)	0.16 (0.37)	0.60*** (0.52)
Underweight (BAZ <-2 SD) (1/0)	0.01 (0.11)	0.01 (0.11)	0.01 (0.11)	0.01 (0.11)	0.00 (0.00)
Underweight (WAZ <-2 SD) (1/0)	0.07 (0.25)	0.08 (0.27)	0.08 (0.27)	0.08 (0.27)	0.00 (0.00)
Stunting (HAZ <-2 SD) (1/0)	0.21 (0.41)	0.21 (0.41)	0.21 (0.41)	0.22 (0.41)	0.20 (0.42)
Wasting (WHZ <-2 SD) (1/0)	0.01 (0.11)	0.01 (0.11)	0.01 (0.11)	0.01 (0.11)	0.00 (0.00)
Overweight (BAZ >+1 SD)	0.28 (0.45)	0.18 (0.39)	0.18*** (0.39)	0.19 (0.39)	1.00*** (0.00)
Overweight (WHZ >+1SD)	0.24 (0.43)	0.14 (0.35)	0.14*** (0.35)	0.14 (0.35)	1.00*** (0.00)

DB, double burden of malnutrition; FG, food group, BAZ, body mass index-for-age Z-score; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score; VA, vitamin A

Note: Values are means with SD in parentheses. DB2 child overweight (BMIZ >+1SD) and micronutrient deficient; DB2.1 overweight (WHZ >+1SD) and micronutrient deficiency.

[a] household health =1 if a member with chronic disease exists within the household.

*Difference between female children affected by DB 2/DB 2.1 and non-affected is significant at 10% level. **Difference between female children affected by DB 2/DB 2.1 and non-affected is significant at 5% level. ***Difference between female children affected by DB 2/DB 2.1 and non-affected is significant at 1% level

Table A3.8 Descriptive statistics of male children (total), non-affected and DB-affected children (DB 2 and DB 2.1)

	Total (n=95)	Non DB 2 (n=87)	DB 2 (n=8)	Non-DB 2.1 (n=90)	DB 2.1 (n=5)
Household characteristics					
Kisii county (1/0)	0.76 (0.43)	0.75 (0.44)	0.88 (0.35)	0.74 (0.44)	1.00 (0.00)
Male household head (1/0)	0.79 (0.41)	0.77 (0.42)	1.00 (0.00)	0.79 (0.41)	0.80 (0.45)
Age household head (years)	46.67 (10.79)	46.90 (10.78)	44.25 (11.29)	46.31 (10.91)	53.20 (5.59)
Marital status household head (1/0)	0.82 (0.39)	0.80 (0.40)	1.00 (0.00)	0.81 (0.39)	1.00 (0.00)
Farming occupation household head (1/0)	0.60 (0.49)	0.59 (0.50)	0.75 (0.46)	0.59 (0.49)	0.80 (0.45)
Education household head (years)	9.48 (3.55)	9.57 (3.64)	8.50 (2.27)	9.59 (3.56)	7.60 (3.21)
Number of adults (count)	2.57 (1.15)	2.57 (1.19)	2.50 (0.76)	2.58 (1.18)	2.40 (0.55)
Number of children (count)	3.51 (1.49)	3.52 (1.49)	3.38 (1.60)	3.44 (1.48)	4.60* (1.52)
Household health[a] (1/0)	0.06 (0.28)	0.07 (0.30)	0.00 (0.00)	0.07 (0.29)	0.00 (0.00)
Protected water source (1/0)	0.62 (0.49)	0.62 (0.49)	0.63 (0.52)	0.61 (0.49)	0.80 (0.45)
Toilet facility existent (1/0)	0.99 (0.10)	0.99 (0.11)	1.00 (0.00)	0.99 (0.11)	1.00 (0.00)
Agricultural income (1,000 Ksh)	83.57 (121.65)	83.32 (125.60)	86.29 (70.08)	83.25 (124.25)	89.42 (65.24)
Total income (1,000 Ksh)	318.66 (871.32)	326.57 (908.13)	232.64 (232.09)	323.47 (894.88)	232.13 (116.16)
Farm size (acres)	1.24 (1.11)	1.17 (1.07)	1.96* (1.34)	1.17 (1.05)	2.43** (1.55)
Food purchase (share)	56.14 (13.39)	56.27 (13.67)	54.76 (10.49)	56.50 (13.51)	49.75 (9.87)
Child variables					
Male child (1/0)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Age (months)	36.74 (12.46)	36.32 (12.33)	41.25 (13.76)	37.12 (12.39)	29.80 (12.87)
Received breastmilk (1/0)	0.97 (0.18)	0.97 (0.18)	1.00 (0.00)	0.97 (0.18)	1.00 (0.00)
Still breastfed (1/0)	0.07 (0.26)	0.08 (0.27)	0.00 (0.00)	0.08 (0.27)	0.00 (0.00)
Disease suffered within last 14 days (1/0)	0.23 (0.42)	0.24 (0.43)	0.13 (0.35)	0.23 (0.43)	0.20 (0.45)
Dietary diversity (12 FG)	6.63 (1.12)	6.66 (1.08)	6.38 (1.60)	6.66 (1.10)	6.20 (1.48)
Minimum dietary diversity (7 FG)	4.13 (0.99)	4.14 (0.95)	4.00 (1.41)	4.14 (0.99)	3.80 (1.10)
Micronutrient deficiency (1/0)	0.29 (0.46)	0.23 (0.42)	1.00*** (0.00)	0.26 (0.44)	1.00*** (0.00)
VA deficiency (1/0)	0.05 (0.22)	0.06 (0.23)	0.00 (0.00)	0.04 (0.21)	0.20 (0.45)
Iron deficiency (1/0)	0.13 (0.33)	0.11 (0.32)	0.25 (0.46)	0.12 (0.33)	0.20 (0.45)

Zinc deficiency (1/0)	0.29 (0.46)	0.23 (0.42)	1.00*** (0.00)	0.26 (0.44)	1.00*** (0.00)
Underweight (BAZ <-2 SD) (1/0)	0.01 (0.10)	0.01 (0.11)	0.00 (0.00)	0.01 (0.11)	0.00 (0.00)
Underweight (WAZ <-2 SD) (1/0)	0.06 (0.24)	0.07 (0.25)	0.00 (0.00)	0.07 (0.25)	0.00 (0.00)
Stunting (HAZ <-2 SD) (1/0)	0.24 (0.43)	0.24 (0.43)	0.25 (0.46)	0.24 (0.43)	0.20 (0.45)
Wasting (WHZ <-2 SD) (1/0)	0.01 (0.10)	0.01 (0.11)	0.00 (0.00)	0.01 (0.11)	0.00 (0.00)
Overweight (BAZ >+1 SD)	0.27 (0.45)	0.21 (0.41)	1.00*** (0.00)	0.24 (0.43)	0.80*** (0.45)
Overweight (WHZ >+1SD)	0.21 (0.41)	0.18 (0.39)	0.50** (0.53)	0.17 (0.37)	1.00*** (0.00)

DB, double burden of malnutrition; FG, food group; BAZ, body mass index-for-age Z-score;, WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score; VA, vitamin A

Note: Values are means with SD in parentheses. DB2 child overweight (BMIZ >+1SD) and micronutrient deficient; DB2.1 overweight (WHZ >+1SD) and micronutrient deficiency.

[a] household health =1 if a member with chronic disease exists within the household.

*Difference between male children affected by DB 2/DB 2.1 and non-affected is significant at 10% level. **Difference between male children affected by DB 2/DB 2.1 and non-affected is significant at 5% level. ***Difference between male children affected by DB 2/DB 2.1 and non-affected is significant at 1% level

Household-sample statistics

Table A3.9 Descriptive of households (total), non-affected and DB-affected households (DB 3 – DB 5)

	Total (n=173)	Non-DB 3 (n=172)	DB 3 (n=1)	Non-DB 4 (n=168)	DB 4 (n=5)	Non-DB 5 (n=151)	DB 5 (n=22)
Household characteristics							
Kisii county (1/0)	0.69 (0.46)	0.69 (0.46)	1.00 (.)	0.69 (0.46)	0.80 (0.45)	0.70 (0.46)	0.68 (0.48)
Male household head (1/0)	46.41 (11.86)	46.30 (11.80)	66.00 (.)	46.37 (11.84)	47.80 (14.08)	46.52 (11.72)	45.64 (13.07)
Age household head (years)	0.83 (0.37)	0.84 (0.37)	0.00 (.)	0.85 (0.36)	0.40*** (0.55)	0.84 (0.37)	0.77 (0.43)
Marital status household head (1/0)	0.84 (0.37)	0.84 (0.36)	0.00 (.)	0.85 (0.36)	0.60 (0.55)	0.84 (0.37)	0.82 (0.39)
Farming occupation household head (1/0)	0.60 (0.49)	0.60 (0.49)	1.00 (.)	0.59 (0.49)	1.00* (0.00)	0.60 (0.49)	0.59 (0.50)
Education household head (years)	9.32 (3.38)	9.36 (3.34)	2.00 (.)	9.40 (3.37)	6.40** (2.51)	9.44 (3.36)	8.50 (3.49)
Number of adults (count)	3.35 (1.46)	3.33 (1.45)	6.00 (.)	3.31 (1.44)	4.60* (1.67)	3.31 (1.46)	3.59 (1.47)
Number of children (count)	2.50 (1.15)	2.50 (1.15)	3.00 (.)	2.50 (1.15)	2.60 (1.14)	2.44 (1.16)	2.91* (0.97)
Household health[a] (1/0)	0.08 (0.31)	0.08 (0.31)	0.00 (.)	0.08 (0.31)	0.20 (0.45)	0.08 (0.32)	0.09 (0.29)
Protected water source (1/0)	0.62 (0.49)	0.62 (0.49)	0.00 (.)	0.62 (0.49)	0.60 (0.55)	0.62 (0.49)	0.59 (0.50)
Toilet facility existent (1/0)	0.98 (0.15)	0.98 (0.15)	1.00 (.)	0.98 (0.13)	0.80*** (0.45)	0.98 (0.14)	0.95 (0.21)
Agricultural income (1,000 Ksh)	94.83 (152.50)	94.95 (152.93)	73.49 (.)	92.99 (150.19)	156.67 (230.96)	90.23 (140.49)	126.40 (219.78)
Total income (1,000 Ksh)	277.65 (660.75)	278.68 (662.54)	99.24 (.)	279.53 (669.23)	214.26 (264.08)	287.05 (701.07)	213.10 (245.24)
Farm size (acres)	1.27 (1.19)	1.26 (1.19)	2.23 (.)	1.26 (1.20)	1.41 (0.79)	1.27 (1.22)	1.24 (0.99)
Food purchase (share)	56.39 (13.85)	56.38 (13.89)	57.89 (.)	56.41 (13.96)	55.55 (10.99)	56.99 (14.01)	52.22 (12.18)
Dietary diversity (12 FG)	6.38 (0.89)	6.39 (0.88)	5.00 (.)	6.39 (0.89)	6.00 (0.71)	6.36 (0.89)	6.50 (0.86)
Adult characteristics[b]							
Micronutrient deficiency (1/0)	0.59 (0.49)	0.59 (0.49)	1.00 (.)	0.59 (0.49)	0.60 (0.55)	0.57 (0.50)	0.73 (0.46)
VA deficiency (1/0)	0.20 (0.40)	0.20 (0.40)	1.00 (.)	0.20 (0.40)	0.40 (0.55)	0.19 (0.39)	0.32 (0.48)

Iron deficiency (1/0)	0.51 (0.50)	0.51 (0.50)	1.00 (.)	0.51 (0.50)	0.60 (0.55)	0.50 (0.50)	0.64 (0.49)
Zinc deficiency (1/0)	0.13 (0.33)	0.12 (0.33)	1.00 (.)	0.12 (0.32)	0.40* (0.55)	0.13 (0.34)	0.09 (0.29)
Overweight/obese (1/0)	0.62 (0.49)	0.62 (0.49)	0.00 (.)	0.61 (0.49)	0.80 (0.45)	0.57 (0.50)	0.95*** (0.21)
Child characteristics							
Male child (1/0)	0.52 (0.50)	0.52 (0.50)	1.00 (.)	0.52 (0.50)	0.60 (0.55)	0.52 (0.50)	0.55 (0.51)
Age (months)	35.91 (12.44)	35.77 (12.35)	59.00 (.)	35.64 (12.27)	45.00** (16.20)	35.27 (12.23)	40.27* (13.28)
Received breastmilk (1/0)	0.97 (0.18)	0.97 (0.18)	1.00 (.)	0.97 (0.17)	0.80** (0.45)	0.97 (0.18)	0.95 (0.21)
Still breastfed (1/0)	0.12 (0.33)	0.12 (0.33)	0.00 (.)	0.12 (0.32)	0.20 (0.45)	0.13 (0.33)	0.09 (0.29)
Disease suffered within last 14 days (1/0)	0.21 (0.41)	0.22 (0.41)	0.00 (.)	0.22 (0.42)	0.00 (0.00)	0.21 (0.41)	0.23 (0.43)
Dietary diversity (12 FG)	6.75 (1.11)	6.76 (1.11)	5.00 (.)	6.76 (1.11)	6.40 (1.14)	6.70 (1.07)	7.09 (1.34)
Minimum dietary diversity (7 FG)	4.17 (0.92)	4.17 (0.91)	3.00 (.)	4.17 (0.91)	4.20 (1.10)	4.13 (0.86)	4.45 (1.22)
Micronutrient deficiency (1/0)	0.29 (0.46)	0.29 (0.46)	1.00 (.)	0.29 (0.46)	0.40 (0.55)	0.30 (0.46)	0.23 (0.43)
VA deficiency (1/0)	0.08 (0.27)	0.08 (0.27)	1.00 (.)	0.08 (0.27)	0.20 (0.45)	0.09 (0.28)	0.05 (0.21)
Iron deficiency (1/0)	0.09 (0.28)	0.08 (0.28)	1.00 (.)	0.08 (0.27)	0.40** (0.55)	0.09 (0.28)	0.09 (0.29)
Zinc deficiency (1/0)	0.25 (0.43)	0.24 (0.43)	1.00 (.)	0.24 (0.43)	0.40 (0.55)	0.25 (0.44)	0.23 (0.43)
Underweight (BAZ < -2 SD) (1/0)	0.01 (0.11)	0.01 (0.08)	1.00 (.)	0.01 (0.08)	0.20*** (0.45)	0.01 (0.08)	0.05 (0.21)
Underweight (WAZ < -2 SD) (1/0)	0.07 (0.25)	0.06 (0.25)	1.00 (.)	0.04 (0.20)	1.00*** (0.00)	0.05 (0.21)	0.23*** (0.43)
Stunting (HAZ < -2 SD) (1/0)	0.23 (0.42)	0.23 (0.42)	1.00 (.)	0.21 (0.41)	1.00*** (0.00)	0.12 (0.33)	1.00*** (0.00)
Wasting (WHZ < -2 SD) (1/0)	0.01 (0.11)	0.01 (0.08)	1.00 (.)	0.01 (0.08)	0.20*** (0.45)	0.01 (0.08)	0.05 (0.21)
Overweight (BAZ >+1 SD)	0.26 (0.44)	0.26 (0.44)	0.00 (.)	0.27 (0.44)	0.00 (0.00)	0.25 (0.43)	0.36 (0.49)
Overweight (WHZ >+1SD)	0.20 (0.40)	0.20 (0.40)	0.00 (.)	0.21 (0.41)	0.00 (0.00)	0.21 (0.41)	0.18 (0.39)

DB, double burden of malnutrition; FG, food group; BAZ, body mass index-for-age Z-score; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score; VA, vitamin A

Note: Values are means with SD in parentheses. All definitions include adult overweight (BMI ≥25.0) and differ in classification of undernutrition of children as follows: DB 3 child underweight (BAZ < -2 SD), DB 4 child underweight (WAZ < -2 SD), DB 5 child stunting (HAZ < -2 SD)

[a] household health =1 if a member with chronic disease exists within the household. [b] for all adult variables =1 if one of the adults is deficient or both together.

*Difference between households affected by DB and non-affected is significant at 10% level. **Difference between households affected by DB and non-affected is significant at 5% level. ***Difference between households affected by DB and non-affected is significant at 1% level.

Table A3.10 Descriptive of households (total), non-affected and DB-affected households (DB 6 – DB 7)

	Total (n=173)	Non-DB 6 (n=172)	DB 6 (n=1)	Non-DB 7 (n=143)	DB 7 (n=30)
Household characteristics					
Kisii county (1/0)	0.69 (0.46)	0.69 (0.46)	1.00 (.)	0.66 (0.47)	0.83* (0.38)
Male household head (1/0)	46.41 (11.86)	46.30 (11.80)	66.00 (.)	45.49 (11.74)	50.80** (11.65)
Age household head (years)	0.83 (0.37)	0.84 (0.37)	0.00 (.)	0.83 (0.38)	0.83 (0.38)
Marital status household head (1/0)	0.84 (0.37)	0.84 (0.36)	0.00 (.)	0.83 (0.38)	0.90 (0.31)
Farming occupation household head (1/0)	0.60 (0.49)	0.60 (0.49)	1.00 (.)	0.57 (0.50)	0.73 (0.45)
Education household head (years)	9.32 (3.38)	9.36 (3.34)	2.00 (.)	9.52 (3.29)	8.37* (3.68)
Number of adults (count)	3.35 (1.46)	3.33 (1.45)	6.00 (.)	3.29 (1.49)	3.60 (1.30)
Number of children (count)	2.50 (1.15)	2.50 (1.15)	3.00 (.)	2.62 (1.15)	1.97*** (1.00)
Household health[a] (1/0)	0.08 (0.31)	0.08 (0.31)	0.00 (.)	0.08 (0.30)	0.07 (0.37)
Protected water source (1/0)	0.62 (0.49)	0.62 (0.49)	0.00 (.)	0.62 (0.49)	0.63 (0.49)
Toilet facility existent (1/0)	0.98 (0.15)	0.98 (0.15)	1.00 (.)	0.97 (0.17)	1.00 (0.00)
Agricultural income (1,000 Ksh)	94.83 (152.50)	94.95 (152.93)	73.49 (.)	82.92 (127.07)	151.62** (234.16)
Total income (1,000 Ksh)	277.65 (660.75)	278.68 (662.54)	99.24 (.)	273.99 (712.71)	295.10 (319.05)
Farm size (acres)	1.27 (1.19)	1.26 (1.19)	2.23 (.)	1.14 (0.91)	1.87*** (1.97)
Food purchase (share)	56.39 (13.85)	56.38 (13.89)	57.89 (.)	56.29 (14.14)	56.85 (12.61)
Dietary diversity (12 FG)	6.38 (0.89)	6.39 (0.88)	5.00 (.)	6.44 (0.88)	6.10* (0.88)
Adult characteristics[b]					
Micronutrient deficiency (1/0)	0.59 (0.49)	0.59 (0.49)	1.00 (.)	0.50 (0.50)	1.00*** (0.00)
VA deficiency (1/0)	0.20 (0.40)	0.20 (0.40)	1.00 (.)	0.16 (0.37)	0.40*** (0.50)
Iron deficiency (1/0)	0.51 (0.50)	0.51 (0.50)	1.00 (.)	0.43 (0.50)	0.90*** (0.31)
Zinc deficiency (1/0)	0.13 (0.33)	0.12 (0.33)	1.00 (.)	0.08 (0.27)	0.37*** (0.49)
Overweight/obese (1/0)	0.62 (0.49)	0.62 (0.49)	0.00 (.)	0.55 (0.50)	0.93*** (0.25)
Child characteristics					
Male child (1/0)	0.52 (0.50)	0.52 (0.50)	1.00 (.)	0.53 (0.50)	0.47 (0.51)

Age (months)	35.91 (12.44)	35.77 (12.35)	59.00 (.)	35.03 (11.70)	40.10** (14.99)
Received breastmilk (1/0)	0.97 (0.18)	0.97 (0.18)	1.00 (.)	0.96 (0.20)	1.00 (0.00)
Still breastfed (1/0)	0.12 (0.33)	0.12 (0.33)	0.00 (.)	0.11 (0.32)	0.17 (0.38)
Disease suffered within last 14 days (1/0)	0.21 (0.41)	0.22 (0.41)	0.00 (.)	0.21 (0.41)	0.23 (0.43)
Dietary diversity (12 FG)	6.75 (1.11)	6.76 (1.11)	5.00 (.)	6.80 (1.10)	6.47 (1.14)
Minimum dietary diversity (7 FG)	4.17 (0.92)	4.17 (0.91)	3.00 (.)	4.17 (0.91)	4.13 (0.94)
Micronutrient deficiency (1/0)	0.29 (0.46)	0.29 (0.46)	1.00 (.)	0.15 (0.36)	1.00*** (0.00)
VA deficiency (1/0)	0.08 (0.27)	0.08 (0.27)	1.00 (.)	0.03 (0.17)	0.33*** (0.48)
Iron deficiency (1/0)	0.09 (0.28)	0.08 (0.28)	1.00 (.)	0.04 (0.20)	0.30*** (0.47)
Zinc deficiency (1/0)	0.25 (0.43)	0.24 (0.43)	1.00 (.)	0.14 (0.35)	0.77*** (0.43)
Underweight (BAZ < -2 SD) (1/0)	0.01 (0.11)	0.01 (0.08)	1.00 (.)	0.01 (0.08)	0.03 (0.18)
Underweight (WAZ < -2 SD) (1/0)	0.07 (0.25)	0.06 (0.25)	1.00 (.)	0.07 (0.26)	0.07 (0.25)
Stunting (HAZ < -2 SD) (1/0)	0.23 (0.42)	0.23 (0.42)	1.00 (.)	0.24 (0.43)	0.17 (0.38)
Wasting (WHZ < -2 SD) (1/0)	0.01 (0.11)	0.01 (0.08)	1.00 (.)	0.01 (0.08)	0.03 (0.18)
Overweight (BAZ >+1 SD)	0.26 (0.44)	0.26 (0.44)	0.00 (.)	0.24 (0.43)	0.33 (0.48)
Overweight (WHZ >+1SD)	0.20 (0.40)	0.20 (0.40)	0.00 (.)	0.18 (0.39)	0.30 (0.47)

DB, double burden of malnutrition; FG, food group; BAZ, body mass index-for-age Z-score; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score; VA, vitamin A

Note: Values are means with SD in parentheses. All definitions include adult overweight (BMI ≥25.0) and differ in classification of undernutrition of children as follows: DB 6 child wasting (WHZ < -2 SD), DB7 child micronutrient deficient.

[a] household health =1 if a member with chronic disease exists within the household. [b] for all adult variables =1 if one of the adults is deficient or both together.

*Difference between households affected by DB and non-affected is significant at 10% level. **Difference between households affected by DB and non-affected is significant at 5% level. ***Difference between households affected by DB and non-affected is significant at 1% level.

Table A3.11 Marginal effects on probability of DB 3 – DB 7 affected households

	DB 3	DB 4	DB 5	DB 6	DB 7
Male household head (1/0)			-0.0476		0.0061
			(0.0581)		(0.0692)
Age household head	0.0000	-0.0014	-0.0036	0.0000	0.0029
(years)	(.)	(0.0015)	(0.0027)	(.)	(0.0025)
Education household head	-0.0000	-0.0096**	-0.0136*	-0.0000	-0.0151*
(years)	(.)	(0.0049)	(0.0075)	(.)	(0.0083)
Agricultural income (1,000	0.0000	0.0001	0.0002	0.0000	0.0003*
Ksh)	(.)	(0.0001)	(0.0002)	(.)	(0.0002)
Number children (count)	-0.0000	0.0039	0.0431**	-0.0000	-0.0688***
	(.)	(0.0076)	(0.0195)	(.)	(0.0243)
Household health [a] (1/0)	0.0000	0.0201	0.0411	0.0000	-0.1327
	(.)	(0.0304)	(0.0697)	(.)	(0.1115)
Food purchase (share)	-0.0000	-0.0002	-0.0039**	-0.0000	0.0018
	(.)	(0.0007)	(0.0018)	(.)	(0.0019)
N	173	173	173	173	173
r2_p	1	0.1387	0.091	1	0.1181

DB, double burden of malnutrition

Note: Coefficients are average marginal effects with standard errors in parentheses. Standard errors are clustered at the household level. All definitions include adult overweight (BMI ≥25.0) and differ in classification of undernutrition of children as follows: DB 3 child underweight (BAZ < -2 SD), DB 4 child underweight (WAZ < -2 SD), DB 5 child stunting (HAZ < -2 SD), DB 6 child wasting (WHZ < -2 SD), DB7 child micronutrient deficient.

[a] household health =1 if a member with chronic disease exists within the household.

*Significant at 10% level. **Significant at 5% level. ***Significant at 1% level.

Table A3.12 Explanation of variables used

Variable name	Definition/Construction
Household characteristics	
Kisii county (1/0)	=1, if county is Kisii (0=Nyamira)
Male household head (1/0)	=1, if household head is male
Age household head (years)	Age in years of household head
Marital status household head (1/0)	=1, if household head is married monogamous
Education household head (years)	School education (y) attendance of household head
Farming occupation household head (1/0)	=1, if main occupation involves farming activities
Number adults (count)	Count of adult (>12 y)individuals within household
Number children (count)	Count of children (<12 y) within household
Household health (1/0)	=1, if adult stated existence of chronical disease
Protected water source (1/0)	=1, if water is piped into the compound, from protected borehole, well or spring
Toilet facility existent (1/0)	=1, if pit latrine or flushed toilet exist at household
Agricultural income (1,000 Ksh)	in 1,000 Ksh (crop, livestock income)
Total income (1,000 Ksh)	in 1,000 Ksh
Farm size (acres)	Total Land owned by acres

Food purchase (share)	Share of purchased food items to consumed food items
Dietary diversity (12 FG)	Mean of dietary diversity scores of individuals
Adult Characteristics [a]	
Male adult (1/0)	=1, if adult individual is male (0=female)
Age (years)	Age in years of interviewed adult
Education (years)	School education in years attendance of interviewed adult
Body mass index (kg/m^2)	Body mass index (BMI) in kg/m²
Micronutrient deficiency (1/0)	=1, if at least one adult is micronutrient deficient
VA deficiency (1/0)	=1, if at least one adult is VA deficient
Iron deficiency (1/0)	=1, if at least one adult is iron deficient
Zinc deficiency (1/0)	=1, if at least one adult is zinc deficient
Overweight/Obese (1/0)	=1, if at least one adults has a BMI (in kg/m²) ≥25.0
Child Characteristics	
Gender (1/0)	=1, if child is male
Age (month)	Age of child in month
Received breastmilk (1/0)	=1, if child received breastmilk at one point in life
Still breastfed (1/0)	=1, if the child is still receiving breastmilk
Disease suffered within last 14 days (1/0)	=1, if child suffered from diarrhea, anemia, fever, fatigue or pneumonia in the last 14 days
Dietary diversity score (12 FG)	Score between 0-12 food groups
Minimum dietary diversity (7 FG)	Score between 0-7 food groups
Micronutrient deficiency (1/0)	=1, if child is deficient in iron, zinc, or VA
Zinc deficiency (1/0)	=1, if child is zinc deficient
VA deficiency (1/0)	=1, if child is VA deficient
Iron deficiency (1/0)	=1, if child is iron deficient
Underweight (BAZ <-2 SD) (1/0)	=1, if body mass index-for-age Z-score <-2 SD
Underweight (WAZ <-2 SD) (1/0)	=1, if weight-for-age Z-score is <-2 SD
Stunting (HAZ <-2SD) (1/0)	=1, if height-for-age Z-score id <-2 SD
Wasting (WHZ <-2 SD) (1/0)	=1, if weight-for-height Z-score id <-2 SD
Overweight (BAZ >+1 SD) (1/0)	=1, if body mass index-for-age Z-score is >+1 SD
Overweight (WHZ >+1 SD) (1/0)	=1, if weight-for-height Z-score is >+1 SD

y, years; FG, food group; BMI, body mass index; VA, vitamin A; BAZ, body mass index-for-age Z-score; SD, standard deviation; WAZ, weight-for-age Z-score; HAZ, height-for-age Z-score; WHZ, weight-for-height Z-score

Note: [a] for all adult variables =1 if one of the adults is deficient or both together.

4 General conclusion

Underweight, micronutrient deficiencies and overweight/obesity are contributing factors to the multiple burdens of malnutrition globally. Many low- and middle-income countries face the challenge to address not only undernutrition, but also overweight, obesity and diet-related diseases. Kenya in particular reports an increase in the share of overweight and obesity within children and women. Over 30% of women in reproductive age are overweight or obese. At the same time, the rates of undernutrition, especially of children and in rural areas, remain persistent and a public health concern (KNBS, 2015; Masibo and Makoka, 2012).

This example illustrates the complexity of fighting hunger and malnutrition. At the same time, it depicts the importance of keenly assessing how to measure nutrition. Measurements of nutrition are important to reveal and monitor the food security, hunger and malnutrition situation in the world. Good nutrition with a sufficient nutrient intake is central to grow adequately, to stay healthy and to be a useful member of society.

In spite of notable harmonization approaches, various nutritional measurement methods exist. Use and interpretation depend much on the scope of the research and discipline. Therefore, the first essay of this dissertation (Chapter 2) contributes to the existing literature in comparing different nutritional assessment tools. We have analyzed and compared a large set of dietary and nutrition indicators based on household level and individual level data collected for the same target population. Unlike previous studies, we are able to compare household level and individual level nutritional data from two different methods of data collection. In detail, we calculated dietary indicators from 7d FCR at household level and 24h DR at individual level. Additionally, we collected anthropometric data from a female and male adult, and a child aged 6-59 months. Moreover, we have analyzed the associations between different indicators across household and individual levels, to better understand the associations between different indicators.

Results show that household dietary diversity and food variety scores are positively correlated with individual level dietary diversity and food variety scores for children and also for male and female adults. Similarly, energy and micronutrient consumption levels at the household level are positively correlated with individual level energy and micronutrient intakes for all target groups. This is an important result, because household level 7d FCR data are often widely available, whereas individual level 24h DR are not.

Malnutrition manifests itself in many forms, which displays the multidimensionality of the nutritional situation worldwide. One contributing factor to the complexity is the concurrent existence of underweight, micronutrient deficiencies, and overweight/obesity within nations, regions, households and individuals at the same time. The coexistence is referred to as double burden of malnutrition (DB). It is important to identify and measure this simultaneous occurrence of different forms of malnutrition, in order to address them. However, DB is mostly studied at household level, either including all household members or specifically targeting mother and child pairs. The measures and indicators used to define undernutrition within the DB phenomenon differ between surveys. Undernutrition is defined in most articles using different Z-score indicators for children. Literature that defines undernutrition as micronutrient deficiency is scarce. The second essay of this dissertation (Chapter 3) focuses on measurement issues related to the DB phenomenon, while at the same time assesses the DB situation in Nyanza region, Kenya. We contribute to the literature by applying five different definitions of DB at household level. Within the five different definitions, the indicator to depict undernutrition in children varies, using indicators of underweight, stunting, wasting and micronutrient deficiency. In addition, we look at the prevalence of DB at individual level.

Based on data from a cross-sectional survey in 2016, we show that DB is found in rural Kenya, regardless which definition is applied. Male and female adults as well as children are affected by micronutrient deficiencies along with overweight and obesity. Our results are similar to other articles (Freire et al., 2014; Hutchinson, 2016; Jones et al., 2016; Laillou et al., 2014). Nonetheless we additionally show evidence that also male adults are affected, which is noteworthy as male adults were not yet in the focus. At household level, we find evidence of DB according to the five defined DB situations. More specifically, the highest prevalence is found when we look at the coexistence of an overweight adult member and a micronutrient deficient child. The occurrence of DB shows that provision of food alone is not the solution. Excess intake of energy-dense food items, which do not contain sufficient amounts of essential micronutrients, may be an important factor contributing to the situation. To our knowledge, this is the first study analyzing DB phenomena in rural Africa, which highlights the complexity of multiple burdens of malnutrition.

A few limitations have to be acknowledged concerning this dissertation. First, the sampling strategy of both papers was based on a group level approach. This is not a usual strategy for surveys assessing nutritional outcome variables, especially targeting individual household

members. Moreover, a household who chose to be a member of a farmer group may have different household characteristics than non-member households. Especially farmer groups are widespread in rural Kenya and due to the structure of villages, farmer groups were the easiest entry point into the community. Second, any kind of survey data suffers a certain amount of imprecision. Nutritional assessment methods face problems of under- and overestimation. In particular, dietary recalls suffer from the so-called recall bias, as they rely on the ability of memorization and the conceptualization skill to estimate portion sizes. To account for these challenges and to reduce measurement errors, an extensive training and harmonizing approach before data collection, and constant refreshers were conducted with the enumerators, as well as a precise data cleaning and management. Additionally, to minimize estimation bias, we collected 24h DR twice on non-consecutive days, to better estimate habitual intake. Third, the number of observations in the analyses of Chapter 3 is relatively low, due to incomplete data-sets. Some individuals were not found within the second day of the survey, even though they were informed several times. Fourth, the assessment of micronutrient deficiencies is calculated via food intake data, which captures the insufficient intake of certain micronutrients. A more precise method to assess micronutrient deficiency is via blood analysis. However, the information derived from biochemical measurements is cost intensive, nutrient-specific, and invasive (Nelson et al., 2004). Hence, biochemical measurements are only used for very specific purposes. Dietary intake data are widely used to assess energy, macro- and micronutrient intake, as it is more cost-efficient, and therefore we think it is a valuable measure.

Overall, this dissertation contributed towards a better understanding of nutritional measurements. We contributed to the discussion whether certain indicators can be used as proxies for others for which data may not easily be available in certain situations, finding that it is possible. Additionally, we identified nutritional inequality within households and individuals in rural areas, and therefore the need of addressing underweight, micronutrient deficiencies and overweight/ obesity at the same time.

References

Arimond, M., Ruel, M.T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *The Journal of Nutrition*, 134, 2579–2585. https://doi.org/https://doi.org/10.1093/jn/134.10.2579

Bingham, S.A. (1991). Limitations of the various methods for collecting dietary intake data. *Annals of Nutrition & Metabolism*, 35, 117–127. https://doi.org/10.1159/000177635

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., Onis, M. de, Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet* 382, 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Bühler, D., Hartje, R., Grote, U. (2017). Can household food security predict individual undernutrition? Evidence from Cambodia and Lao PDR (No. dp-594), Hannover Economic Papers (HEP). Wirtschaftswissenschaftliche Fakultät, Leibniz Universtiy Hannover, Germany.

Caballero, B. (2005). A nutrition paradox--underweight and obesity in developing countries. *The New England Journal of Medicine*, 352, 1514–1516. https://doi.org/10.1056/NEJMp048310

Carletto, C., Zezza, A., Banerjee, R. (2013). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. *Global Food Security*, 2, 30–40. https://doi.org/10.1016/j.gfs.2012.11.006

Chávez Zander, U. (2014). *Agrobiodiversity, cultural factors and their impact on food and nutrition security: a case-study in the south-east region of the Peruvian Andes*.(Doctoral dissertation). Justus-Liebig-University Gießen, Germany: VVB Laufersweiler Verlag, Gießen, Lahn, Germany.

Chege, C.G.K., Andersson, C.I.M., Qaim, M. (2015). Impacts of Supermarkets on Farm Household Nutrition in Kenya. *World Development*, 72, 394–407. https://doi.org/10.1016/j.worlddev.2015.03.016

Chiputwa, B., Qaim, M. (2016). Sustainability Standards, Gender, and Nutrition among Smallholder Farmers in Uganda. *The Journal of Development Studies*, 52, 1241–1257. https://doi.org/10.1080/00220388.2016.1156090

Cisse-Egbuonye, N., Ishdorj, A., McKyer, E.L.J., Mkuu, R. (2017). Examining Nutritional Adequacy and Dietary Diversity Among Women in Niger. Maternal and Child Health Journal, 21, 1408–1416. https://doi.org/10.1007/s10995-016-2248-x

Coates, J.C., Colaiezzi, B.A., Bell, W., Charrondiere, U.R., Leclercq, C. (2017). Overcoming Dietary Assessment Challenges in Low-Income Countries: Technological Solutions Proposed by the International Dietary Data Expansion (INDDEX) Project. *Nutrients,* 9, 289. https://doi.org/10.3390/nu9030289

Cogill B, (2003). *Anthropometric Indicators Measurement Guide.* Food and Nutrition Technical Assistance: Washington DC, USA.

de Haen, H., Klasen, S., Qaim, M. (2011). What do we really know? Metrics for food insecurity and undernutrition. *Food Policy*, 36, 760–769. https://doi.org/10.1016/j.foodpol.2011.08.003

de Onis, M., Blössner, M. (2003). The World Health Organization Global Database on Child Growth and Malnutrition: methodology and applications. *International Journal of Epidemiology*, 32, 518–526. https://doi.org/10.1093/ije/dyg099

de Onis, M., Onyango, A., Van den Broeck, J., Chumlea, C., Martorell, R. (2004). Measurement and Standardization Protocols for Anthropometry Used in the Construction of a New International Growth Reference. Food and Nutrition Bulletin, 25, S27–S36. https://doi.org/10.1177/15648265040251S104

Development Initiatives (2017). *Global Nutrition Report 2017: Nourishing the SDGs.* Development Initiatives: Bristol, UK. Retrieved March 6, 2018, from http://globalnutritionreport.org/the-report/

Dieffenbach, S., Stein, A.D. (2012). Stunted child/overweight mother pairs represent a statistical artifact, not a distinct entity. *The Journal of Nutrition*, 142, 771–773. https://doi.org/10.3945/jn.111.153387

Doak, C., Adair, L.S., Bentley, M., Monteiro, C., Popkin, B.M. (2005). The dual burden household and the nutrition transition paradox. *International Journal of Obesity*, 29, 129–136. https://doi.org/10.1038/sj.ijo.0802824

Drewnoski, A. (2017). Sustainable, Healthy Diets: Models and Measures. In: Biesalski, H.K., Drewnoski, A., Dwyer, J.T., Strain, J., Weber, P., Eggersdorfer, M. (Eds.), *Sustainable Nutrition in a Changing World*. Cham, Switzerland: Springer International Publishing AG, pp. 25–34.

Dwyer, J., Drewnoski, A. (2017). Overview: Food and Nutrition Security. In: Biesalski, H.K., Drewnoski, A., Dwyer, J.T., Strain, J., Weber, P., Eggersdorfer, M. (Eds.), *Sustainable Nutrition in a Changing World*. Cham, Switzerland: Springer International Publishing AG, pp. 3-24.

Food and Agriculture Organization of the United Nation (FAO), United Nations University (UNU), & World Health Organization (WHO) (2004). *Human energy requirements, Report of a Joint FAO/WHO/UNU Expert Consultation*: *Rome, 17-24 October 2001*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved March 31, 2012, from http://www.fao.org/docrep/007/y5686e/y5686e00.htm

Food and Agriculture Organization of the United Nation (FAO), Family Health International (FHI 360) (2016). *Minimum Dietary Diversity for Women (MDD-W): A Guide for Measurement.* Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved November, 30, 2016, from http://www.fantaproject.org/monitoring-and-evaluation/minimum-dietary-diversity-women-indicator-mddw

Food and Agriculture Organization of the United Nation (FAO), International Fund for Agricultural Development (IFAD), United Nations Children's Fund (UNICEF), World Food Programme (WFP), World Health Organization (WHO). (2017). *The State of Food Security and Nutrition in the World 2017. Building resilience for peace and food security*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved October, 12, 2017, from https://www.wfp.org/content/2017-state-food-security-and-nutrition-world-sofi-report

Food and Agriculture Organization of the United Nation (FAO), International Fund for Agricultural Development (IFAD), World Food Programme (WFP). (2015). *The State of Food Insecurity in the World 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved June, 29, 2015, from http://www.fao.org/3/a-i4646e.pdf.

Freire, W.B., Silva-Jaramillo, K.M., Ramírez-Luzuriaga, M.J., Belmont, P., Waters, W.F. (2014). The double burden of undernutrition and excess body weight in Ecuador. The American Journal of Clinical Nutrition, 100, 1636S–43S. https://doi.org/10.3945/ajcn.114.083766

Garrett, J.L., Ruel, M.T. (2005). Stunted child-overweight mother pairs: prevalence and association with economic development and urbanization. *Food and Nutrition Bulletin*, 26, 209–221. https://doi.org/10.1177/156482650502600205

Habte, T.-Y., Krawinkel, M. (2016). Dietary Diversity Score: A Measure of Nutritional Adequacy or an Indicator of Healthy Diet? *Journal of Nutrition and Health Sciences,* 3 (3) 303. https://doi.org/10.15744/2393-9060.3.303

Hanandita, W., Tampubolon, G. (2015). The double burden of malnutrition in Indonesia: Social determinants and geographical variations. *SSM - Population Health*, 1, 16–25. https://doi.org/10.1016/j.ssmph.2015.10.002

Hatløy, A., Hallund, J., Diarra, M.M., Oshaug, A. (2000). Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition*, 3, 57–65. https://doi.org/10.1017/S1368980000000628

Hatløy, A., Torheim, L.E., Oshaug, A. (1998). Food variety--a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*, 52, 891–898. https://doi.org/10.1038/sj.ejcn.1600662

Headey, D., Ecker, O. (2013). Rethinking the measurement of food security: from first principles to best practice. *Food Security*, 5, 327–343. https://doi.org/10.1007/s12571-013-0253-0

Hoddinott, J., Yohannes, Y. (2002). Dietary Diversity as a Household Food Security Indicator. Washington, D.C, USA: Food and Nutrition Technical Assistance Project, FHI 360. Retrieved April, 17, 2015, from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.394.7357&rep=rep1&type=pdf

Hotz, C., Lubowa, A., Sison, C., Moursi, M., Loechl, C. (2012). *A Food Composition Table for Central and Eastern Uganda* (HarvestPlus Technical Monograph Series No. 9). Washington, DC, USA: HarvestPlus.

Hutchinson, C. (2016). A review of iron studies in overweight and obese children and adolescents: a double burden in the young? *European Journal of Nutrition*, 55, 2179–2197. https://doi.org/10.1007/s00394-016-1155-7

International Food Policy Research Institute (IFPRI). (2017). *2017 Global Food Policy Report.* Washington DC, USA: International Food Policy Research Institute. https://doi.org/10.2499/9780896292529. Retrieved March, 27, 2017, from http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/131085

International Food Policy Research Institute (IFPRI). (2016). *Global Nutrition Report 2016: From Promise to Impact Ending Malnutrition by 2030*. Washington, DC, USA: International Food Policy Research Institute. https://doi.org/10.2499/9780896295841. Retrieved November, 6, 2016, from http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130354

International Food Policy Research Institute (IFPRI). (2015). *Global Nutrition Report 2015: Actions and accountability to advance nutrition and sustainable development*. Washington, DC, USA: International Food Policy Research Institute. https://doi.org/10.2499/9780896298835. Retrieved March, 3, 2018, from http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/129443

Ihab, A.N., Rohana, A.J., Manan, W.M.W., Suriati, W.N.W., Zalilah, M.S., Rusli, A.M. (2013). The Coexistence of Dual Form of Malnutrition in a Sample of Rural Malaysia. *International Journal of Preventive Medicine*, 4, 690–699.

Institute of Medicine (IOM). (2006). *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington, DC, USA: Institute of Medicine, National Academy Press. Retrieved June, 1, 2017, from http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx

Jehn, M., Brewis, A. (2009). Paradoxical malnutrition in mother-child pairs: untangling the phenomenon of over- and under-nutrition in underdeveloped economies. *Economics and Human Biology*, 7, 28–35. https://doi.org/10.1016/j.ehb.2009.01.007

Jones, A.D., Acharya, Y., Galway, L.P. (2016). Urbanicity Gradients Are Associated with the Household- and Individual-Level Double Burden of Malnutrition in Sub-Saharan Africa. *The Journal of Nutrition*, 146, 1257–1267. https://doi.org/10.3945/jn.115.226654

Kant, A.K. (1996). Indexes of overall diet quality: a review. *Journal of the American Dietetic Association*, 96, 785–791. https://doi.org/10.1016/S0002-8223(96)00217-9

Keding, G.B., Msuya, J.M., Maass, B.L., Krawinkel, M.B. (2012). Relating dietary diversity and food variety scores to vegetable production and socio-economic status of women in rural Tanzania. *Food Security*, 4, 129–140. https://doi.org/10.1007/s12571-011-0163-y

Kennedy, G., Ballard, T., Dop, M. (2010). *Guidelines for measuring household and individual dietary diversity*. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved Mai, 29, 2017, from http://www.fao.org/docrep/014/i1983e/i1983e00.htm

Kennedy, G., Berardo, A., Papavero, C., Horjus, P., Ballard, T., Dop, M., Delbaere, J., Brouwer, I.D. (2010). Proxy measures of household food consumption for food security assessment and surveillance: comparison of the household dietary diversity and food consumption scores. *Public Health Nutrition*, 13, 2010–2018. https://doi.org/10.1017/S136898001000145X

Kennedy, G., Pedro, M., Seghieri, C., Nantel, G., Brouwer, I. (2007). Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. *The Journal of Nutrition*, 137, 472–477. https://doi.org/10.1093/jn/137.2.472

Kimani-Murage, E.W., Muthuri, S.K., Oti, S.O., Mutua, M.K., van de Vijver, S., Kyobutungi, C. (2015). Evidence of a Double Burden of Malnutrition in Urban Poor Settings in Nairobi, Kenya. *PLoS One*, 10. https://doi.org/10.1371/journal.pone.0129943

Kenya National Bureau of Statistics. (2015). *Demographic and Health Survey 2014*. Nairobi, Kenya: Kenya National Bureau of Statistics. Retrieved Mai, 15, 2017, from http://dhsprogram.com/publications/publication-fr308-dhs-final-reports.cfm

Koppmair, S., Kassie, M., Qaim, M. (2017). Farm production, market access and dietary diversity in Malawi. *Public Health Nutrition*, 20, 325–335. https://doi.org/10.1017/S1368980016002135

Laillou, A., Yakes, E., Le, T.H., Wieringa, F.T., Le, B.M., Moench-Pfanner, R., Berger, J. (2014). Intra-individual double burden of overweight and micronutrient deficiencies among Vietnamese women. *PLoS ONE,* 9, e110499. https://doi.org/10.1371/journal.pone.0110499

Lim, S.S., Vos, T., Flaxman, A.D., Danaei, G., Shibuya, K., Adair-Rohani, H., … , Memish, Z.A. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet,* 380, 2224–2260. https://doi.org/10.1016/S0140-6736(12)61766-8

Lukmanji, Z., Hertzmark, E., Mlingi, N., Assey, V., Ndossi, G., Fawzi, W. (2008). *Tanzania food composition Tables*. Dar es Salaam, Tanzania: MUHAS- TFNC, HSPH. Retrieved August, 14, 2012, from http://harvardschoolofpublichealth.com/nutritionsource/files/tanzania-food-composition-tables.pdf

Masibo, P.K., Makoka, D. (2012). Trends and determinants of undernutrition among young Kenyan children: Kenya Demographic and Health Survey; 1993, 1998, 2003 and 2008-2009. *Public Health Nutrition*, 15, 1715–1727. https://doi.org/10.1017/S1368980012002856

Mbuvi, H., Muthengia, J., Kenyanya, O. (2013). Determination of Potassium Levels in Intensive Subsistence Agricultural Soils in Nyamira County, Kenya. *International Journal of Agriculture and Forestry,* 3, 294–302. https://doi.org/10.5923/j.ijaf. 20130307.06

Mei, Z., Grummer-Strawn, L.M. (2007). Standard deviation of anthropometric Z-scores as a data quality assessment tool using the 2006 WHO growth standards: a cross country analysis. *Bulletin of the World Health Organization*, 85, 441–448. https://doi.org/10.2471/BLT.06.034421

Moursi, M.M., Arimond, M., Dewey, K.G., Trèche, S., Ruel, M.T., Delpeuch, F. (2008). Dietary diversity is a good predictor of the micronutrient density of the diet of 6- to 23-month-old children in Madagascar. *The Journal of Nutrition*, 138, 2448–2453. https://doi.org/10.3945/jn.108.093971

Nelson, M., Beresford, S.A.A., Kearney, J.M., 2004. Nutritional Epidemiology. In: Gibney, M.J., Margetts, B.M., Kearney, J.M., Arab, L. (Eds.), *Public Health Nutrition,* The Nutrition Society Textbook Series. Oxford, UK: Blackwell Science Ltd, pp. 26–65.

O'Donnell, O., Van Doorsaler, E., Wagstaff, A., Lindelow, M. (2008). *Analyzing Health Equity Using Household Survey Data. A Guide to Techniques and Their Implementation*. Washington, DC: World Bank, WBI Learning Resources Series. Retrieved February, 27, 2018, from https://openknowledge.worldbank.org/handle/10986/6896

Patterson, R.E., Pietinen, P., 2004. Assessment of Nutritional Status in Individuals and Populations. In: Gibney, M.J., Margetts, B.M., Kearney, J.M., Arab, L. (Eds.), *Public Health Nutrition*, The Nutrition Society Textbook Series. Oxford, UK: Blackwell Science Ltd, pp. 66–82.

Popkin, B.M., Adair, L.S., Ng, S.W. (2012.) Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews*, 70, 3–21. https://doi.org/10.1111/j.1753-4887.2011.00456.x

Rathnayake, K.M., Madushani, P., Silva, K. (2012). Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka. *BMC Research Notes*, 5, 469. https://doi.org/10.1186/1756-0500-5-469

Roemling, C., Qaim, M. (2013). Dual burden households and intra-household nutritional inequality in Indonesia. *Economics & Human Biology*, 11, 563–573. https://doi.org/10.1016/j.ehb.2013.07.001

Ruel, M.T. (2003). Operationalizing dietary diversity: a review of measurement issues and research priorities. *The Journal of Nutrition*, 133, 3911S–3926S. https://doi.org/10.1093/jn/133.11.3911S

Ruel, M.T., Harris, J., Cunningham, K. (2013). Diet Quality in Developing Countries. In: Preedy, V.R., Hunter, L.-A., Patel, V.B. (Eds.), *Diet Quality, Nutrition and Health*. New York, USA: Springer, pp. 239–261. https://doi.org/10.1007/978-1-4614-7315-2_18

Saibul, N., Shariff, Z.M., Lin, K.G., Kandiah, M., Ghani, N.A., Rahman, H.A. (2009). Food variety score is associated with dual burden of malnutrition in Orang Asli (Malaysian indigenous peoples) households: implications for health promotion. *Asia Pacific Journal of Clinical Nutrition*, 18, 412–422.

Savy, M., Martin-Prével, Y., Traissac, P., Delpeuch, F. (2007). Measuring dietary diversity in rural Burkina Faso: comparison of a 1-day and a 3-day dietary recall. *Public Health Nutrition*, 10, 71–78. https://doi.org/10.1017/S1368980007219627

Sehmi, J.K. (1993). *National Food Composition Tables and The planning of Satisfactory Diets in Kenya*. Nairobi, Kenya: Kenya Government Press.

Stadlmayr, B., Charrondiere, U.R., Enujiugha, V.N., Bayili, R.G., Fagbohoun, E.G., ... , Burlingame, B. (2012). *West African Food Composition Table; Table de composition des aliments d'Afrique de l'Ouest*. Rome, Italy: Food and Agriculture Organization of the United Nations.

Steyn, N.P., Nel, J.H., Nantel, G., Kennedy, G., Labadarios, D. (2006). Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition*, 9, 644–650. https://doi.org/10.1079/PHN2005912

Swindale, A., Bilinsky, P. (2006). *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (v.2)*. Washington, D.C., USA: Food and Nutrition Technical Assistance Project, Academy for Educational Development. Retrieved January, 22, 2014, from http://www.fantaproject.org/monitoring-and-evaluation/household-dietary-diversity-score

Swindale, A., Bilinsky, P. (2005). *Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide*. Washington, D.C., USA: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Torheim, L.E., Ouattara, F., Diarra, M.M., Thiam, F.D., Barikmo, I., Hatløy, A., Oshaug, A. (2004). Nutrient adequacy and dietary diversity in rural Mali: association and determinants. *European Journal of Clinical Nutrition*, 58, 594–604. https://doi.org/10.1038/sj.ejcn.1601853

United States Department of Agriculture. (2017). *USDA Food Composition Database* [Web Page]. United States Department of Agriculture. Retrieved July, 6, 2017, from https://ndb.nal.usda.gov/ndb/

World Health Organization (WHO). (2018a). *WHO/Europe | Nutrition - Body mass index* [Web Page]. World Health Organization. Retrieved January, 29, 2018, from http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi

World Health Organization (WHO). (2018b). *Global Database on Child Growth and Malnutrition* [Web Page]. World Health Organization. Retrieved February, 27, 2018, from http://www.who.int/nutgrowthdb/about/introduction/en/

World Health Organization (WHO). (2018c). *Double burden of malnutrition* [Web Page]. World Health Organization. Retrieved March, 11, 2018, from http://www.who.int/nutrition/double-burden-malnutrition/en/

World Health Organization (WHO). (2017). *The double burden of malnutrition*. (Policy Brief). Geneva, Switzerland: World Health Organization.

World Health Organization (WHO), United Nations Children's Fund (UNICEF), the United States Agency for International Development (USAID), Academy for Educational Development (AED), University of California at Davis (UCDAVIS), International Food Policy Research Institute (IFPRI). (2010). *Indicators for assessing infant and young child feeding practices Part II: Measurement*. Washington DC, USA: World Health Organization. Retrieved October, 31, 2010, from http://www.who.int/nutrition/publications/infantfeeding/9789241596664/en/

World Health Organization (WHO), United Nations Children's Fund (UNICEF). (2009). *WHO child growth standards and the identification of severe acute malnutrition in infants and children: a joint statement by the World Health Organisation and the United Nations Children's Fund*. Geneva, Switzerland; New York, USA: World Health Organization, United Nations Children's Fund. Retrieved March, 5, 2018, from http://www.who.int/nutrition/publications/severemalnutrition/9789241598163/en/

World Health Organization (WHO), United Nations Children's Fund (UNICEF), the United States Agency for International Development (USAID), Academy for Educational Development (AED), University of California at Davis (UCDAVIS), International Food Policy Research Institute (IFPRI). (2008). *Indicators for assessing infant and young child feeding practices Part I: Definitions*. Washington DC, USA: World Health Organization. Retrieved October, 31, 2010, from http://www.who.int/nutrition/publications/infantfeeding/9789241596664/en/

World Health Organization (WHO). (2006). *WHO : Global Database on Body Mass Index* [Web Page]. World Health Organization. Retrieved June, 7, 2017, from http://apps.who.int/bmi/index.jsp?introPage=intro_3.html

WHO Multicentre Growth Reference Study Group (Ed.), 2006. *WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development*. Geneva, Switzerland: World Health Organization. Retrieved February, 19, 2018, from http://www.who.int/childgrowth/publications/en/

World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO) (Eds.). (2004). *Vitamin and mineral requirements in human nutrition, 2nd ed.*. Geneva, Switzerland; Rome, Italy: World Health Organization ; Food and Agriculture Organization of the United Nations.

Wibowo, Y., Sutrisna, B., Hardinsyah, H., Djuwita, R., Korib M, M., Syafiq, A., Tilden, A., Najib, M. (2015). Relationship between intra-household food distribution and coexistence of dual forms of malnutrition. *Nutrition Research and Practice*, 9, 174–179. https://doi.org/10.4162/nrp.2015.9.2.174

Wojcicki, J.M. (2014). The double burden household in sub-Saharan Africa: maternal overweight and obesity and childhood undernutrition from the year 2000: results from World Health Organization Data (WHO) and Demographic Health Surveys (DHS). *BMC Public Health*, 14. https://doi.org/10.1186/1471-2458-14-1124

Zezza, A., Carletto, C., Fiedler, J.L., Gennari, P., Jolliffe, D. (2017). Food counts. Measuring food consumption and expenditures in household consumption and expenditure surveys (HCES). Introduction to the special issue. *Food Policy*, SI: Food counts 72, 1–6. https://doi.org/10.1016/j.foodpol.2017.08.007

General appendix

Questionnaire number (adda_hhid) _____

Georg-August-Universität Göttingen

Africa Harvest BIOTECH FOUNDATION INTERNATIONAL

UNIVERSITY OF NAIROBI

HOUSEHOLD SURVEY 2016

AGRICULTURE AND DIETARY DIVERSITY IN AFRICA: AN APPLICATION OF RANDOMISED CONTROLLED TRIALS IN KISII AND NYAMIRA, KENYA.

Goettingen University-Germany, University of Nairobi-Kenya and Africa Harvest Biotech Foundation International (Africa Harvest) are carrying out a research on different aspects of agricultural development. We are currently doing a survey which aims to provide more understanding about farmers' production and marketing decisions, and nutrition and health status. Your participation in answering these questions is very much appreciated. Your responses will be **COMPLETELY CONFIDENTIAL** and will only be used for research purpose. If you indicate your voluntary consent by participating in this interview, may we begin?

MODULE 0 – HOUSEHOLD ID !

TARGET PERSON: GROUP MEMBER OR HOUSEHOLD HEAD

MODULE 1: HOUSEHOLD DEMOGRAPHIC INFORMATION

MODULE 2: LAND HOLDING IN ACRES

MODULE 3: NON-LABOUR PURCHASED INPUT USE

MODULE 4: CROP UTILIZATION

MODULE 5: LABOUR INPUTS !

MODULE 6: VARIETY/BREED AWARENESS AND UP-TAKE !

MODULE 7: VARIETY/BREED ATTRIBUTES, KNOWLEDGE & PERCEPTION

MODULE 8: LIVESTOCK PRODUCTION AND MARKETING

MODULE 9: HOUSEHOLD ASSETS

MODULE 11: OTHER SOURCES OF INCOME AND TRANSFER

MODULE 12: NON-FOOD EXPENDITURE

MODULE 13: INFORMATION ON CREDIT ACCESS

MODULE 15: ACCESS TO SOCIOECONOMIC INFRASTRUCTURE !

MODULE 17: SHOCKS EXPERIENCENCED BY THE HOUSEHOLD !

TARGET PERSON: GROUP MEMBER

MODULE 18: SOCIAL CAPITAL ENDOWMENT

MODULE 14: COMMUNITY OUTREACH METHODS

MODULE 19: SOCIAL NETWORKS

TARGET PERSON: PERSON RESPONSIBLE FOR FOOD PREPARATION !

MODULE 20: HOUSEHOLD FOOD CONSUMPTION !

TARGET PERSON: MOTHER OR CARETAKER OF CHILD BETWEEN THE AGE OF SIX TO 59 MONTHS

MODULE 21: CHILD QUESTIONNAIRE – ONLY ONE CHILD WILL BE CONSIDERED

1. ! **TARGET PERSON: FIRT INDIVIUDAL**

MODULE 22/1- FIRST INDIVIDUAL QUESTIONNAIRE (1)

!!!! MODULE 23/1 - DECISION MAKING

2. ! **TARGET PERSON: SECOND INDIVUDAL**

MODULE 22/1- SECOND INDIVIDUAL QUESTIONNAIRE (2)

!!!!MODULE 23/2 - DECISION MAKING

Questionnaire number (adda_hhid) _____

We are researchers from Göttingen University-Germany, University of Nairobi-Kenya and Africa Harvest Biotech Foundation International (Africa Harvest). We are conducting research that aims to improve the knowledge on agriculture-nutrition linkages in the African small farm sector. We are particularly interested in understanding the mechanisms through which farmers can effectively adopt agricultural technologies that may improve their nutrition and health. We are currently conducting the first round of the survey last year and now will do a follow-up round.

This informed consent is for smallholder farmers [like you] who belong to farmer groups and have engaged in farming activities during the last one year (October, 2015 to September, 2016). We are inviting you to participate in this research that mainly focuses on nutrition and health status of smallholder farmers in this area. We will ask you and some members of your household detailed questions on various topics related to agriculture, social networks, nutrition and health. We will also need to take measurements of the height and weight of selected adults and children below 5 years of age in your household. Your participation in this interview is entirely voluntary. Your responses will be treated with utmost confidentiality and the data will be used for research purposes only.

Do you have any questions that we need to clarify? [Make clarifications in case there are questions]If *No*, do you agree to take part in this survey, including the interviews and the measurements of adults and children?

If *Yes*let the potential respondent write name and sign below

Name_____

Signature_____

Questionnaire number (adda_hhid) _____

MODULE 0 – HOUSEHOLD ID

1	Household ID		8	County		12	**First visit date**	
2	Group ID		9	Sub-County		1=Interview completed 2= Interview partly completed 3= Specify		
3	Date of interview		18	Ward		14	**Enumerator Name**	
4	Start Time (24 Hr)		17	Division		13	**Second visit date**	
5	End time (24 Hr)		10	Village		1=Interview completed 2= Interview partly completed 3= Specify		
6	HH head Full Name		11	GPS Coordinates		**15**	**Enumerator Name 1**	
7	Cell phone number					**16**	**Enumerator Name 2**	

Questionnaire number (adda_hhid) _____

TARGET PERSON: GROUP MEMBER OR HOUSEHOLD HEAD

Respondent MEMID: _____

MODULE 1: HOUSEHOLD DEMOGRAPHIC INFORMATION *(reference period between 1st Oct 2015 and 30th Sep 2016)*

Household composition*: Please list all household members (All those who are under the care of household head in terms of food and shelter provision, and those who normally live and eat their meals together), starting with the household head.*

1	2	3	4	5	6	7	10	11	12	13	14
MEMID	**Name of the HH member**	**Gender** *M = 1 F= 0*	**R/ship with HH head** (*Codes A)*	**Age in years**	**Years of formal education** (*Highest level attained*)	**Marital Status** *(Codes B)*	**# of months in the last 12 months [NAME] has been away from home**	**Main Occupation based on time spent** *(Codes D)*	**Household farm labour contribution** *(for those above 16 years of age in the upper category) (Codes E)*	**How many hours per day are dedicated to farm activities? (hr)**	**If you had a larger farm how many hours per day would be dedicated to farm acitivities?**
			1								

Code A
1= Head
2=Spouse
3=Son/daughter
4=Father/mother
5=Sister/brother
6=Grandchildren
7=Grandparents
8=Step children
9=Step parents
10 = Father/mother-in-law
11 =Sister/brother-in-law
12 = House girl
13 =Farm labourer
16=Nephew/Niece
14 = Other relative
15= Other Unrelated

Code B
1= Married-monogamous
2= Married polygamous
3= Single
4= Divorced/separated
5= Widow/widower

Code D
0= None
1= Farming (crop + livestock)
2= Casual labour on-other farm
3= Casual labour off-farm
4= Self-employed off-farm
5= Salaried employment (civil servant etc)
6=Student/school
77= Other (Specify)_____

Code E
1= Part time
2= Fulltime
3=Does not work on farm

Questionnaire number (adda_hhid) _____

MODULE 2: LAND HOLDING IN ACRES *(period between 1st Oct 2015 and 30th Sep 2016)*

2.1. How much land do you own in acres? _____

2.2. How much of your total land is under homestead? _____

2.3. Do you have a title deed for your land? _____Yes=1 (all land), No=0 (no land), Partly=3

Land category	**Short rain season (Oct-Nov 2015)**		**Long rain season (Mar-Apr 2016)**	
	Cultivated	Fallow	Cultivated	Fallow
1. Own land (A)				
2. Rented in (B)				
3. Rented out (C)				
4. Total irrigated land				

2.4. What is the average cost of renting land per acre (Ksh/per year)? _____

Questionnaire number (adda_hhid) _____

CODES FOR MODULE 3

Codes A

1 Maize
2 Rice
3 Sorghum
4 Millet
5 Cassava
6 KK 15 Beans
7 Other Field beans
8 Bananas
9 Cabbage
10 Cowpea
11 Groundnut
12 Soybean
13 Sweet potatoes
14 Orange Fleshed Sweet Potatoes (OFSP)
15 Black night shade
16 Sugarcane
17 Pineapple
18 Jute Mallow (Omutere)
19 Amaranthas leaves (Emboga)
20 Pumpkin leaves
21 Sukuma wiki (Kales)
22 Carrots
23 Passion Fruit
24 Irish potato
25 Bean leaves
26 Tea
27 Onion
29 Coffee
30 Napier grass
31 Avocado
32 Spider Plant
33 Vine Spinache
34 Pumpkin
35 Trees
36 Mangoes
37 Guava
38 Wheat
39 Paw Paw
40 Tomatoes
41 Loquat
42 Green grams
43 Tree Tomato
44 Strawberry
45 Spring Onion
46 Desmodium
47 Spinach
48 Arrow Roots
49 Green Peas
50 Physallis/Gooseberry
51 Corriander
52 Capsicum
53 Pepper
54 Grass
55 Butternut
56 Lemon
57 Beetroot
58 Cumcumber
59 Water melon
60 Tree Seedlings
61 Raspberry
63 Pyrethrum
64 Cowpea Leaves
77 Other_____
78 Other_____
79 Other_____

Codes B

0. Local
1. Improved
2. Mixture

Codes C

1. Kilogram
2. Litre
3. 90 Kg bag (40 Gorogoro)
4. 50 Kg bag
5. 25 Kg bag
6. Gorogoro (2.25 kg)
7. Debe (18 kg/ 8 Gorogoro)
8. Wheelbarrow
9. Ox-cart
10. Bunch (bananas)
11. Piece/number
12. Not yet harvested (for perennials only)
13. Stools
14. Glass (250 gr)
15. Suckers
16. Bucket
17. Ml
18. Spoonful
19. 5 kg bag
20. 10 kg Bag
22. Yellow paper bag
23. Grams
24. Pick up
25. Trees
26. Green paper bag
27. Lines
28. Packet (250g)
29. Crates
30. Bundle
31. Handful
32. Cuttings
33. Vines
35. Lorry
36. Seeds
37. Bushes
38. 45kg bag
39. Bottle top
40. Seedlings
41. Tonne
42. 500 Ml glass
45. Cobs
46. Poles
47. Crop failure
48. Black paper bag
77 Other (specify)_____

Questionnaire number (adda_hhid) _____

MODULE 3: NON-LABOUR PURCHASED INPUT USE (*1st Oct 2015 and 30th Sep 2016 planting seasons, record separately by plots*)

1	2	3	12	4	5	6			7			8	9			10			11	
Plot Code (*Use alphabets in Cap*)	Crop Grown ***A***	Land under crop (*acre*)	Intercrop (1=Yes; 0=No)	Number of trees	Crop variety **B**	Seed **C**			Fertiliser(planting) (Fill once for intercrops) **C**			Oxen/ tractor hire Cost	Farm manure (Fill once for intercrops) ***C***			Pesticides/herbicides ***C***			Crop output ***C***	
						Qty	units	Price /Unit	Qty	Units	Price /Unit	Ksh	Qty	unit	Price /unit	Qty	units	Price /unit	Qty	Unit
Short Rains																				
	KK 15 (6)																			
Long Rains																				
	KK 15 (6)																			
Perennial Crops																				

Questionnaire number (adda_hhid) _____

CODES FOR MODULE 4 (*period between **1st Oct 2015 and 30th Sep 2016***)

Codes A

1 Maize
2 Rice
3 Sorghum
4 Millet
5 Cassava
6 KK 15 Beans
7 Other Field beans
8 Bananas
9 Cabbage
10 Cowpea
11 Groundnut
12 Soybean
13 Sweet potatoes
14 Orange Fleshed Sweet Potatoes (OFSP)
15 Black night shade
16 Sugarcane
17 Pineapple
18 Jute Mallow (Omutere)
19 Amaranthas leaves (Emboga)
20 Pumpkin leaves
21 Sukuma wiki (Kales)
22 Carrots
23 Passion Fruit
24 Irish potato
25 Bean leaves
26 Tea
27 Onion
29 Coffee
30 Napier grass
31 Avocado
32 Spider Plant
33 Vine Spinache
34 Pumpkin
35 Trees
36 Mangoes
37 Guava
38 Wheat
39 Paw Paw
40 Tomatoes
41 Loquat
42 Green grams
43 Tree Tomato
44 Strawberry
45 Spring Onion
46 Desmodium
47 Spinach
48 Arrow Roots
49 Green Peas
50 Physallis/Gooseberry
51 Corriander
52 Capsicum
53 Pepper
54 Grass
55 Butternut
56 Lemon
57 Beetroot
58 Cumcumber
59 Water melon
60 Tree Seedlings
61 Raspberry
63 Pyrethrum
64 CowPea Leaves

77 Other_____
78 Other_____
79 Other_____

Codes C

1. Kilogram
2. Litre
3. 90 Kg bag (40 Gorogoro)
4. 50 Kg bag
5. 25 Kg bag
6. Gorogoro (2.25 kg)
7. Debe (18 kg/ 8 Gorogoro)
8. Wheelbarrow
9. Ox-cart
10. Bunch (bananas)
11. Piece/number
12. Not yet harvested (for perennials only)
13. Stools
14. Glass
15. Suckers
16. Bucket
17. Ml
18. Spoonful
19. 5 kg bag
20. 10 kg Bag
22. Yellow paper bag
23. Grams
24. Pick up
25. Trees
26. Green paper bag
27. Lines
28. Packet (250g)
29. Crates
30. Bundle
31. Handful
32. Cuttings
33. Vines
35. Lorry
36. Seeds
37. Bushes
38. 45kg bag
39. Bottle top
40. Seedlings
41. Tonne
42. 500 Ml glass
45. Cobs
46. Poles
47. Crop failure
48. Black paper bag
77 Other (specify)_____

Codes D

1. Farm gate
2. Village market
3. Main market
4. Collection center
77. Other (specify)_____

Codes E

1. Own bicycle
2. Bodaboda
3. Hired truck
4. PSV
5. Donkey/oxen
6. Walking
7. Own truck
8. Taxi
77 Other (sp.)
99. NA

Code F

1. Male household head
2. Female household head
3. Female spouse
4. Joint decision
5. Male spouse
77 Other (specify)_____

Questionnaire number (adda_hhid) _____

MODULE 4: CROP UTILIZATION (*in the period between 1st Oct 2015 and 30th Sep 2016)*

1	2		3		4		5		6		7		8		9	11	10	12	13	14
Crop **Code A** (Aggregated crop)	Total Crop Output (Enter the total crop output from the plots)		Consumption		Saved as seed		Gift, tithe, donations, paid as wages		Stored		Quantity sold		Price		Point of most sales	Main Mode of transport	Travel time to the point of sale (minutes)	Who mostly decides revenue use?	Who mostly decides technology use e.g. variety	Who mostly decides how much of the total output is consumed by the household?
	Qty	*Unit* **C**	*Qty*	*Unit* **C**	*Qty*	*Unit* **C**	*Qty*	*Unit* **C**	*Qty*	*Unit* **C**	*Qty*	*Unit* **C**	*Ksh*	*Unit* **C**	**D**	**E**		**F**	**F**	**F**
Short rain																				
KK 15 (6)																				
Long rain																				
KK 15 (6)																				
Perennial crop																				

Questionnaire number (adda_hhid) _____

4.1 How easily can you access the market for sale of your produce (crop and or livestock)? *(Circle the applicable)*
1. Very easy 2. Easy 3.Difficult 4. Very difficult

4.2 Rank three most important market access constraints, if there exists any (***Prompt Codes G below***) 1._____2._____3._____
Codes G:1. Poor infrastructure 2. Distant markets 3. Poor market prices 4. Cheating on quality standards/weighing scales 5.Lack of contracts or reliable buyers 6.Exploitative middlemen
77. Other (specify): _____

4.7 In the last one year did you order: 1 KK15 ____ (1.Yes; 0. No); 2. Kuroiler chicken ____ (1.Yes; 0. No);

If the respondent is not growing KK 15 beans, skip to module 5

4.3 How easily can you market your KK15/beans? *(Circle the applicable)*
1. Very easy 2. Easy 3. Difficult 4. Very difficult

4.4 What is the **MAIN REASON** for your answer in 4.3 above *(Circle the applicable)*
1. Distance to market 2. Colour of beans 3. Prices 4. Yield 5. Taste 6. Pest and disease resistance 7. Cooking quality 8. Nutritional value
77. Others (specify)_____ -99 N/A

4.5 When did you first order the KK15 bean seed? Date _____ Month_____

4.6 When did you receive KK 15 seeds for the first order? Date_____ Month_____

MODULE 5: LABOUR INPUTS (*01.Oct 2015 to 30. Sept 2016 planting seasons, record **total man hours** worked by plot)*

1	2	3	4	5
Plot code	Plot size in acres	Plot manager *(F=0, M=1; Joint=3)*	Ploughing & harrowing Planting & thinning Applying fertiliser, Pesticide application (1st and 2nd) Weeding (1st and 2nd) Harvesting /Threshing/shelling/bagging	
			Family	Hired
Short Rains				
A				
B				
C				
D				
E				
F				
G				
H				
Long Rains				
A				
B				
C				
D				
E				
F				
G				
H				

Questionnaire number (adda_hhid) _____

5.6 What is the average daily wage rate for men and women in this village? Men_____ Ksh/per day Women_____Ksh/per day

5.7 Given all the family labour (manual) available in your household, what is the **maximum land size** in acres that you could potetntially cultivate and keep under livestock? _____

MODULE 6: VARIETY/BREED AWARENESS AND UP-TAKE

	1	2	3	14	4	15	5	6	7	8	9	10	11	12	13
	New breed/variety/technologies	Have you ever heard of this variety/breed? *(1= Yes; 0=No) If No skip to the next technology*	**Main** source of information on the new variety/breed? **Codes A**	How easily can you obtain information from **main source**? **Code D**	Have you ever planted /kept this variety/breed? *(1=Yes; 0=No) If NO, skip to 5*	If yes, name the most important reason for adopting **Code E**	If No to Q4, what was the main reason? **Codes C** *Then Skip to Q10*	What was the **main** source of breed kept/variety planted that year? **Codes B**	Number of seasons the variety has been planted, **since first** planting?	Number of years /variety/breed has been planted/kept	If you did not plant this variety/keep breed in 2016 what was the main reason? **Codes C**	Will you plant the variety/ keep the breed in future? *(1= Yes; 0=No, 88=don't know) if Yes skip to Q12*	What is the main reason? **Codes C**	Are you aware of the nutritional value of this variety or breed? (yes = 1, No = 0)	If yes to Q12 what was the source of information? **Code A**
3	*Kuroiler chicken*														
4	*Beans(KK15)*														

Code A	**Code B**	**Code C**		**Code D**	**Code E**	
1= Farmer Coop/Union 2= Farmer group 3= Extension staff/office 4= Other farmers (neighbours/relative) 5= Market (e.g. Agro vet/stockist) 6= Radio programs 7= Research centre (trials/demos) (*name___* 8= NGO/CBO *(name_____* *9= Health centre/Practitioner* 77= Other*(specify_____)*	1= NGO free *(name_____)* 2= NGO subsidy *(specify_____)* 3= Extension staff demo plots 4= Other farmers 5= Market (Agrovet/local trader/stockist) 6= Farmer group/coop 7=Agricultural association/training centre 77= Other*(specify _____)*	1= Seed not available 2=Day old chicks not available 3=Lacked cash to buy seed/DOCs 4= Lacked credit to buy seed/DOCs 5= Prefer other varieties/breeds 6=Susceptible to diseases/pests	7=Poor taste 8=Low yielding/lays fewer eggs 9=Late maturing /longer maturity period 10=Low market prices/demand 11=High input requirements 12=Limited land to experiment/plant 13= Limited information 77= Other*(specify _____)*	1=Very easy 2= Easy 3=Difficult 4= Very difficult	1= Seed easily available 2= Day old chicks easily available 3= Availabiliy of cash to buy seed/DOCs 4= Availability of credit to buy seed/DOCs 5= Preference KK 15/Kuroiler 6= Resistance to diseases/pests	7= Good taste 8= High yielding/lays many eggs 9= Early maturing /shorter maturity period 10= High market prices/demand 11= Lower input requirements 12= Adequate land to experiment/plant 13= Sufficient information 14= Seed/DOC Subsidy 77= Other*(specify _____)*

Questionnaire number (adda_hhid) _____

MODULE 7: VARIETY/BREED ATTRIBUTES, KNOWLEDGE & PERCEPTION

Instructions: Only ask the following questions to farmers who have ever heard or grown or kept the new technologies (listed below).

If *Yes*, ask for his/her perception of the performance of the technology (ies) against the listed attributes compared to his/her preferred local variety /breed. *Please mark the respondent's response with a* ***tick*** *in the appropriate cells below. If No, skip to the next module.*

	1	2				3			
		Kuroiler chicken				*Beans (KK15)*			
	Do you know the attributes of the following technologies? *Yes=1 No=0*	_____ *If No Skip to the next technology, IF Yes ask for the attributes*				_____ *If No Skip to the next technology, IF Yes ask for the attributes*			
	Technology attributes	*Better*	*Worse*	*No difference*	*Don't know*	*Better*	*Worse*	*No difference*	*Don't know*
1	Early maturity								
2	Yield								
3	Pest and disease resistance								
4	Marketability (demand)								
5	Cost of planting materials								
6	Market price received								
7	Cost of day old chicks								
8	Taste								
9	Lays more eggs								

7.8 How easily can you market your Kuroiler chicken*? (Circle the applicable)*
1. Very easy 2. Easy 3.Difficult 4. Very difficult 88. DNK

7.9 How easily can you market your Kuroiler eggs*? (Circle the applicable)*
1. Very easy 2. Easy 3.Difficult 4. Very difficult 88. DNK

7.10 What is the **MAIN REASON** for your answer in 7.8 above *(Circle the applicable)*
1.Early maturity 2.Pest and disease resistance 3.Maketability 4.Market price received 5. Cost of day old chicks 6. Taste 7. Lay more eggs 77.Others (specify) -99 N/A

7.11 What is the **MAIN REASON** for your answer in 7.9 above *(Circle the applicable)*
1. Taste 2 Price 3. Size 4. Colour of the yolk -99 N/A

Questionnaire number (adda_hhid) _____

MODULE8: LIVESTOCK PRODUCTION AND MARKETING

8.1 For the last **12 months *(1st Oct 2015 and 30th Sep 2016)***, please give details of revenue and cost of livestock production?

(Please include all animals on the farm last year also those that were later sold or died) If no livestock is owned skip to next module)

	1	2a	2b	3a	3b	4a	4b	5a	5b	6	7	8	9	10	11	12	13
	Animal species	Stock at the beginning of the period (01.Oct.2015)		Changes over the years				Stock at the end of 30.Sep.2016		Cash expenditures between 10/15 and 9/16 Value in Ksh				Who decides sale?	Who decides revenue use?	Who decides technology use e.g. breed	Who mostly decides how much of the total output is consumed by the household?
		(If 0, skip to the next)		Home consumption		Sales											
		Unit	**Ksh**	**Units**	**Ksh**	**Units**	**Ksh**	**Units**	**Ksh**	**Veterinary treatment**	**Feed**	**Hired labor**	**Others, specify:**	**B**	**B**	**B**	**B**
1	Dairy cows/calves																
2	Cow/calves																
3	Goat																
4	Sheep																
5	Kuroiler/chicks																
6	Other chicken/chicks																
7	Donkeys																
8	Pigs																
9	Rabbits																
10	Ducks																
77																	
78																	

8.2 For the last **12 months *(01. Oct 2015 to 30. Sep 2016)***, please give details of production and revenue of the following livestock products?

	1	2		3		4		8		5	6	7
	Animal product/services	Quantity produced		Quantity sold		Quantity Consumed		Other, specify		Price per unit	Who decides sale?	Who decides revenue use?
		Qty	Unit **A**	Qty	Unit **A**	Qty	Unit **A**	Qty	Unit **A**		**B**	**B**
1	Milk											
6	Kuroiler Eggs											
2	Other Eggs											
7	Kuroiler Manure											
3	Manure											
4	Honey											
5	Hide											
77	Others specify_____											

Code A: *1=Kilogram, 2=Litre, 3=90 Kg bag, 4=50 Kg bag, 5=25 Kg bag, 6=Gorogoro, 7=Debe, 8=Wheelbarrow, 9=Ox-cart, 10=Bunch (bananas), 11=Piece/number, 50=Tray, 77=Other (specify) _____*

Code B: *1=Male household head, 2= Female household head, 3=Female spouse, 4=Joint decision, 77= Others (specify)_____*

Questionnaire number (adda_hhid) _____

MODULE 9: HOUSEHOLD ASSETS *(Prompt for each item as listed below)*

9.1 As at September 2016, how many of the following items did the household own that are in **usable/repairable** condition?

To estimate the value ask the respondent how much they would be willing to buy the item in its current state if it were being sold to them

	ASSET	Total Quantity	Estimate total current value of the asset(s) if you were to buy it in its current state		ASSET	Total Quantity	Estimate total current value of the asset(s) if you were to buy it in its current state
1	Tractor			**2**	Slasher		
3	Car/Van			**4**	Axe		
5	Pickup			**6**	Panga		
7	Motorcycle			**8**	Hoes/Jembes		
9	Bicycle			**10**	Spades/shovel		
11	Television			**12**	Chemical spray pump		
13	Radio			**14**	Treadle pump		
15	Mobile Phone			**16**	Powered water pump		
17	Refrigerator			**18**	Mosquito net		
19	Solar panels			**20**	Greenhouse		
21	Generator			**22**	Water tank		
23	Chaff cutter			**24**	Store for farm produce		
25	Ploughs for tractor			**26**	Lanterns		
27	Reaper			**28**	Main house		
29	Ox-plough			**30**	Wheelbarrow		
31	Cart			**32**	Computer/laptop		
33	Livestock Kraal			**34**	Biogas digesters		
35	Other(specify_____			**36**	Other(specify_____		
37				**38**			

Questionnaire number (adda_hhid) _____

MODULE 11: OTHER SOURCES OF INCOME AND TRANSFER

11.1 Do you have off farm employment? _____ (*1= Yes; 0=No*) *If NO, skip to 11.2.*

Please prompt the codes to make sure nothing is forgotten					
1	2	3	4	5a	5b
MEMID	Type of Occupation **A**	Average Number of days worked per month 10/15 – 9/16	Average Number of months worked per year 10/15 – 9/16	Earning per unit	
				Ksh	**B**

***Code A**: 1= Agricultural labour (casual+permanent), 2= Casual labour (non-agricultural), 3= Salary (Permanent non-agricultural employment)*
***Code B**: 1= Day, 2= Month, 3= Year, 4= Lump sum, payment, 77= Other, specify: _____*

11.2 Do you have any other sources of income? _____ (*1= Yes; 0=No*) *If NO, please probe and skip to 12.*

	Please prompt the codes to make sure nothing is forgotten			
	1	2	3	4
	Categories	Code	Type of occupation	Amount /value received between Oct15/ Sept 16/ *for small businesses ask for profit (+) losses (-)*
1	Remittances/gifts/transfers/food aid	1		
2	Pension	2		
3	Small business	1	Brick making	
		2	Carpentry	
		3	Construction	
		4	Grain mill	
		5	Handicrafts	
		6	Beverage, local brew	
		7	Sales in shop, petty trade	
		8	Transport	
		77	Other, specify_____	
4	Sales of forest products	9	Sale of wood and charcoal	
		10	Sale of wild nuts/fruits	
5	Other agric. Income	11	Sale of crop residues	
		12	Leasing out land	
		13	Renting out oxen for ploughing	
		14	Hiring out machinery services to other farmers	
		15	Dividends (T-bills, bonds, shares)	
		16	Tea bonus	
6	Other	35	Betting	

MODULE 12: NON-FOOD EXPENDITURE

Consider the **last year (Oct 15 - Sept 16)** generally how much has your HH spent on the items listed in a typical year (see specification indicated for each item)?

		1	2
		*Read out: Please exclude **Business Expenditures***	How much did your household spend on [ITEM/SERVICE] during the last year (Oct. 15 – Sept 16)?
		Enter 88, if respondent does not know.	Value in Khs
Non-food	1	Rent (housing)	
	2	Personal care supplies	
	3	Clothes, shoes and bags, accessories	
	4	Detergent/washing powder	
	5	Electricity	
	6	Other non-food	
Transportation + communication	7	Fuel, maintenance, insurance, and tax for motorbike/car	
	8	Public transport	
	9	Airtime (incl. MPESA)	
	10	Other transportation, communication	
	11		
	12		
Education	13	School fees, books, Student's dress/uniform, Tuition and rental fee	
	14	Other cost of schooling	
	15		
	16		
Health	17	Medicine, doctor fees	
	18	Other health cost	
	19		
	20		
Social	21	Celebration and funeral cost	
	22	Recreation and entertainment	
	23	Contributions (eg. Church, groups)	
	24	Tobacco (incl. snuff and miraa)	
	25	Insurance (eg. Car, life, health)	
	26	Remittances transferred to other HH	
	27	Other social cost	
	28		
	29		

Questionnaire number (adda_hhid) _____

MODULE 13: INFORMATION ON CREDIT ACCESS

13.1 Could you obtain credit if you needed it for the purpose of operational agricultural expenses (e.g. buying fertilizer paying for labour etc.)? _____*1= Yes, 0= No*

13.2 During the last ***12 months (Oct15 to Sep16)***, have you or any other household member received any credit to buy inputs, or received inputs on credit?_____*1= Yes, 0= No*

13.3 If yes to 13.2, how much did you receive in Ksh? (_____)
(*Include the value of inputs if inputs are provided on credit*)

13.4 How much went into purchasing inputs? (_____)
(*Include the value of inputs if inputs are provided on credit*)

MODULE 15: ACCESS TO SOCIOECONOMIC INFRASTRUCTURE

1	2	3
Social facilities	**Distance to the nearest (km)**	**Most frequently used means of transportation to the facility** *(Use codes A below)*
1. Murram road		
2. Tarmac road		
3. Village market		
4. Main Agricultural input market		
5. Main agricultural product market		
6. Health centre		
7. Agric. Extension agent		

Code A: Means of transport Codes
1= Bicycle; 2= Motorbike; 3= Car; 4= Walk;
77= Others, (specify) _____

Questionnaire number (adda_hhid) _____

MODULE 17: SHOCKS EXPERIENCENCED BY THE HOUSEHOLD

	1	2	3	4
	Please answer the following questions accordingly	Did you experience [NAME OF SHOCK] in the last 12 month? *1= Yes, 0= No* *If No Skip to the next shock*	If yes, how many times has it occurred?	What was the intensity of the last shock to this household? 1= Severe 2= Moderate 3= Mild
	Climatic shocks			
1	Drought			
2	Floods			
3	Frosts			
4	Hailstorm			
	Biological shocks			
5	Pests or diseases that affected crops before harvest			
6	Pests or diseases that led to storage losses			
14	Loss of livestock			
	Economic shocks			
7	Large increase in agricultural input prices			
8	Large decrease in agricultural output prices			
9	Large increase in food prices			
	Other shocks			
10	Loss of family member			
11	Job loss			
12	Acute illness			
77	Other, specify_____			

Questionnaire number (adda_hhid) _____

TARGET PERSON: GROUP MEMBER

Respondent MEMID: _____

MODULE 18: SOCIAL CAPITAL ENDOWMENT

18.1 List all the groups you belong to (*Start with the sampled group)*

1	2	3	4	8	9	10	11
Group Name	Group Type **A**	Please name the most important group function **B**	Year joined	Participation in meetings in the reference period (Oct 15/Sep16) **D**	Your own role in the group **E**	Did the group receive any agricultural training during the reference period (Oct15/Sept16) Yes= 1; N0= 0	Who offered the training? AH= 1; Other= 0, AH+other= 2, DNK= 88

In case sampled group was not named in table above, answer 18.9, 18.10 and 18.11, otherwise skip to 18.2.

18.9 Are you still a member of the sampled group (NAME)? _____ (Yes= 1; No= 0)

18.10 If no: Please shortly explain why you left the group: _____

18.11 In case, you received agricultural training from Africa Harvest in the sampled group: Who mostly informed you about the single training session (time and place)? _____ *(1= Group leader, 2= Other members, 3= Extension officer, 4= He was not informed, 77= Other, specify: _____, -99= N/A)*

18.2. Do you personally exchange information with the local authorities/gov't agencies? _____ (1= Yes; 0= No)

18.6 Do you hold any of the other following positions: _____ *(Multiple answers possible)*

(0= No, 1= Village chief, 2= Village elder, 3= Nyumbakumi, 4= Religious leader, 77= Other_____)

18.7 Are you a close relative to one of the mentioned positions *(1= Yes; 0= No)* _____

18.8 If yes: Name position and relative:

a. Position: _____ (Code 18.6) Relative _____ F

b. Position: _____ (Code 18.6) Relative _____ F

Codes A
1. Farmer cooperative
2. Farmers group
3. Women`s association
4. Youth association
5. Faith-based association/group
6. Funeral association/insurance group
7. Savings and credit group
8. Community based organization
9. Water users association
10. Informal labour sharing group
11. Widow/ widower
12. Family group
77. Other (_____)

Codes B
1. Produce marketing
2. Input access or marketing
3. Seed production
4. Farmer research
5. Savings and credit
6. Welfare/funeral activities
7. Tree planting/Nursery
8. Soil & Water conservation
9. Faith-based organization
10. Input credit
77. Other (_____)

Codes D
1. Always
2. Sometimes
3. Rarely
4. Never

Codes E
1. Official
2. Ex-official
3. Ordinary member

Code F
1. Parent
2. Spouse
3. Child
4. Brother/sister
5. Grandparent
6. Grandchild
7. Nephew/Nice
8. Uncle/Aunt
9. Cousin
10. Mother/father in low
11. Brother/Sister-in law
12. Other relative
13. Neighbour
14. Friend
15. Fellow villager
16. Attend same church/mosque
17. Business colleague
77. Other, specify _____

Questionnaire number (adda_hhid) _____

18.12 Please cross the correct answer:

1= Disagree strongly, 2= Disagree a little, 3= Neither agree nor disagree, 4= Agree a little, 5= Agree strongly, 6= Don't know

I see myself as someone who …		1	2	3	4	5	6
1	…finds it important to help the people nearby, to care for their wellbeing						
2	…Is reserved						
3	…is generally trusting						
4	…finds it important to think up new ideas and be creative, to do things on my own way						
5	…who's happiness depends on people around myself						
6	…is outgoing/social						
7	…tends to find fault with others						
8	…finds it important to maintain harmony within ones group						
9	…would always sacrifices one's self interest for the group						
10	…would stay in a group if they needed me, even if I were not happy with the group						

MODULE 14: COMMUNITY OUTREACH METHODS

14.1 How many visits or contacts with extension agents did you have during the last one year (Oct/2015 to Sep/2016)

1= Govemment extension_____ 2=NGO _____ 3=Private_____

If NO/ZERO to all in 14.1, skip to 14.7

14.2 State the **most important** type of agricultural information that you sought/received from the extension agent in the period between Oct 2015 and Sep 2016 ***(use codes B below)***

1= Govemment extension_____ 2=NGO _____ 3=Private_____

Code B

1. New crop varieties/breeds
2. Agric. credit/insurance
3. Field pest and disease control
4. Input quality
5. Input availability
6. Input markets and prices
7. Output markets and prices
8. Soil and water management
9. Crop rotation/ Minimum tillage
10. Safe use of pesticides
11. Adaptation to climate change
12. Postharvest handling
13. Collective action/farmer organization
14. Livestock production
15. Tree planting
77. Other……
78. Other……

14.3 In general, how would you rate your satisfaction with the information that you received? (***Use codes C below***)

1= Govemment extension_____ 2=NGO _____ 3=Private_____

Code C

1=Very unsatisfied 2 =Unsatisfied 3=Satisfied 4=Very satisfied

Questionnaire number (adda_hhid) _____

TARGET PERSON: GROUP MEMBER

Respondent MEMID: _____

MODULE 18: SOCIAL CAPITAL ENDOWMENT

18.1 List all the groups you belong to (*Start with the sampled group)*

1	2	3	4	8	9	10	11
Group Name	Group Type **A**	Please name the most important group function **B**	Year joined	Participation in meetings in the reference period (Oct 15/Sep16) **D**	Your own role in the group **E**	Did the group receive any agricultural training during the reference period (Oct15/Sept16) Yes= 1; N0= 0	Who offered the training? AH= 1; Other= 0, AH+other= 2, DNK= 88

In case sampled group was not named in table above, answer 18.9, 18.10 and 18.11, otherwise skip to 18.2.

18.9 Are you still a member of the sampled group (NAME)? _____ (Yes= 1; No= 0)

18.10 If no: Please shortly explain why you left the group: _____

18.11 In case, you received agricultural training from Africa Harvest in the sampled group: Who mostly informed you about the single training session (time and place)? _____ *(1= Group leader, 2= Other members, 3= Extension officer, 4= He was not informed, 77= Other, specify: _____, -99= N/A)*

18.2. Do you personally exchange information with the local authorities/gov't agencies? _____ (1= Yes; 0= No)

18.6 Do you hold any of the other following positions: _____ *(Multiple answers possible)*

(0=No, 1= Village chief, 2= Village elder, 3= Nyumbakumi, 4= Religious leader, 77= Other_____)

18.7 Are you a close relative to one of the mentioned positions *(1=Yes; 0=No)* _____

18.8 If yes: Name position and relative: a. Position: _____ (Code 18.6) Relative _____ F

b. Position: _____ (Code 18.6) Relative _____ F

Codes A

1. Farmer cooperative
2. Farmers group
3. Women`s association
4. Youth association
5. Faith-based association/group
6. Funeral association/insurance group
7. Savings and credit group
8. Community based organization
9. Water users association
10. Informal labour sharing group
11. Widow/ widower
12. Family group
77. Other (_____)

Codes B

1. Produce marketing
2. Input access or marketing
3. Seed production
4. Farmer research
5. Savings and credit
6. Welfare/funeral activities
7. Tree planting/Nursery
8. Soil & Water conservation
9. Faith-based organization
10. Input credit
77. Other (_____)

Codes D

1. Always
2. Sometimes
3. Rarely
4. Never

Codes E

1. Official
2. Ex-official
3. Ordinary member

Code F

1. Parent
2. Spouse
3. Child
4. Brother/sister
5. Grandparent
6. Grandchild
7. Nephew/Nice
8. Uncle/Aunt
9. Cousin
10. Mother/father in low
11. Brother/Sister-in law
12. Other relative
13. Neighbour
14. Friend
15. Fellow villager
16. Attend same church/mosque
17. Business colleague
77. Other, specify _____

Questionnaire number (adda_hhid) ____________

MODULE 19: SOCIAL NETWORKS

Code A

1	Parent	**11**	Brother/Sister-in law
2	Spouse	**12**	Other relative
3	Child	**13**	Neighbour
4	Brother/sister	**14**	Friend
5	Grandparent	**15**	Fellow villager
6	Grandchild	**16**	Attend same church/mosque
7	Nephew/Nice	**17**	Business colleague
8	Uncle/Aunt	**77**	Other, specify___
9	Cousin		
10	Mother/father in low		

19.1. General information about each group member

1	2	3	4	5	6	7	8	9	32
MEM ID	Name of the group member	Do you know NAME? *(1=Yes; 0=No), (-99=N/A)*	Please specify your relationship to NAME **A**	Is NAME's plot bordering yours? *(1=Yes; 0=No)*	Do you know the kind of crops NAME grows? *(1=Yes; 0=No)*	Do you know the kind of livestock NAME keeps? *(1=Yes; 0=No)*	Did you lend or borrow any of the following production means from NAME between Oct15 and Sept16? 0=no 1=lend 2=borrow 3=lend &borrow		Do you exchange/ share food items? *(1=Yes; 0=No)*
							Seeds	Agric. Produce	

Questionnaire number (adda_hhid) _____

Code A

1 Very often
2 Often
3 Sometimes
4 Rarely

Code C

1 Preparation of meals
2 Choice of products
3 Nutritional state of children
4 Quantity of food
5 Composition of meals
6 Content of nutrition training
7 Balanced diet
77 Other, specify_____

19.1. Specific interaction within the farmer group *(remind respondent of nutrition definition)*

1	2	14	17	18	19	23	24
MEM ID	Name of the Group Member	How often did you talk with NAME between Oct15/Sep16? A	Did you share information on nutrition with NAME? *(1= Yes; 0= No) If no skip to 19*	Name the specific nutrition topic you mostly talked about with NAME C	Did you share information on agriculture with NAME between Oct15/Sept16? *(1= Yes; 0= No), if no, skip to next person*	Did you share information on Kuroiler chicken with NAME? *(1= Yes; 0= No)*	Did you share information on beans (KK 15) with NAME? *(1= Yes; 0= No)*

19.1. Specific interaction within the farmer group *(remind respondent of nutrition definition)*							
1	**2**	**14**	**17**	**18**	**19**	**23**	**24**
MEM ID	Name of the Group Member	How often did you talk with NAME between Oct15/Sep16? **A**	Did you share information on nutrition with NAME? *(1=Yes;0=No) If no skip to 19*	Name the specific nutrition topic you mostly talked about with NAME **C**	Did you share information on agriculture with NAME between Oct15/Sept16? *(1=Yes; 0=No), if no, skip to next person*	Did you share information on Kuroiler chicken with NAME? *(1=Yes; 0=No)*	Did you share information on beans (KK 15) with NAME? *(1=Yes; 0=No)*

Questionnaire number (adda_hhid) _____

PLEASE USE THE 8 DIGIT MEMID (SEE GROUPLIST)

25. Who do you think is the **most informed person** among the group members concerning **nutrition** information?

_____ MEMID

26. Who do you think is the **most informed person** among the group members concerning **agricultural** information?

_____ MEMID

27. Why did you decide to become a group member? Give reason _____

28. Were you asked by another member to join the group _____ *(Yes=1, No=0)*

29. If yes: By whom? _____ ? MEMID

30. Have you introduced new people to this group? _____ *(Yes=1, No=0)*

31. If yes: Whom? MEMID_____ MEMID_____ MEMID_____

33. Please consider a situation where an organization offers agricultural training to your group.

However, the agricultural extension officers will only train 3 persons of your group. These persons are supposed to forward the information to the group.
Who do you think are the 3 most suitable persons of your group for this purpose?

MEMID_____ MEMID_____ MEMID_____

34. Do you like this approach or would you prefer that all group members should be able to participate in the training?
1=only 3 persons, 2= all group members

35. Now imageine the same situation, but the organization offers nutrition training to your group.

However, the NGO will only train 3 persons of your group,
Who do you think are the 3 most suitable persons of your group for this purpose?

MEMID_____ MEMID_____ MEMID_____

36. Do you like this approach or would you prefer that all group members should be able to participate in the training?
___ 1=only 3 persons, 2= all group member

Questionnaire number (adda_hhid) _____

19.2. SPECIFIC INTERACTIONS OUTSIDE THIS COMMON INTEREST GROUP

19.2.1 Please name the persons outside of your common interest group you most frequently exchanged information about nutrition between Oct15/Sept16. Please name a maximum of 5 persons: OUT ID 1_____ OUT ID 2_____ OUT ID 3_____ OUT ID 4_____ OUT ID 5_____

19.2.2 Please name the persons outside of your common interest group you most frequently exchanged information about agriculture between Oct15/Sept16. Please name a maximum of 5 persons: OUT ID 6_____ OUT ID 7_____ OUT ID 8_____ OUT ID 9_____ OUT ID 10_____

ID Section								
1	2	3	4	6	9	10	12	**11**
OUT ID	Name	NAME's gender *Male=1, female=0*	Please specify your relationship to NAME **A**	How often did you talk with NAME between Oct15/Sep16? **B**	Did you lend or borrow any of the following production means from NAME between Oct15 and Sept16? 0=no 1=lend 2=borrow 3=lend &borrow		Do you exchange/ share food items? (*1=Yes; 0=No*)	If you suddenly needed money, would you ask NAME to lend it to you? (*1=Yes; 0=No*)
					Seeds	Agric. Produce		
40								
40								
40								
40								
40								
40								
40								
40								
40								
40								

12. Who do you think is the **most informed person** among the ones named concerning **nutrition** information? _____OUT ID

13. Who do you think is the **most informed person** among the ones named concerning **agriculture** information? _____OUT ID

Code A								**Code B**	
1	Parent	**6**	Grandchild	**11**	Brother/Sister-in law	**16**	Attend same church/mosque	**1**	Very often
2	Spouse	**7**	Nephew/Nice	**12**	Other relative	**17**	Business colleague	**2**	Often
3	Child	**8**	Uncle/Aunt	**13**	Neighbour	**77**	Other, specify___	**3**	Sometimes
4	Brother/sister	**9**	Cousin	**14**	Friend			**4**	Rarely
5	Grandparent	**10**	Mother/father in low	**15**	Fellow villager				

Questionnaire number (adda_hhid) _____

TARGET PERSON: PERSON RESPONSIBLE FOR FOOD PREPARATION

MODULE 20: HOUSEHOLD FOOD CONSUMPTION – FOR THE LAST 7 DAYS

Respondent MEMID: _____

20.0 Firstly, we would like to ask the following four questions before we continue to ask you about your household food consumption.

	(Please enter the MEMID, if decision was jointly please enter both MEMID)	**MEMID**	**MEMID**
1	Who is mainly responsible for the food preparation in the household?		
2	Who is mainly responsible for food purchase in the household?		
3	Who is the main decision maker on food expenditure in the household?		
4	Who is the main decision maker on non-food expenditure in the household?		

Now we would like to ask about food consumption in the past seven days. Indicate how much of the following food items your household consumed, the prices in Ksh and the source of its origin (This is for all food consumed in the household, by all the people listed on demographic table in Module 1. INCLUDE food prepared at home but eaten outside. EXCLUDE meals prepared outside the home).
Ask how many people were present in the last 7 days? Please note down the number of household members in the following table. Please differentiate between female, male and children, as well as household members and visiting members. Fill in NA if a food item was not consumed in the last 7 days.

5	6	7	8	9	10	11	12
Household members				Visiting members			
Adults		**Children**		**Adults**		**Children**	
Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*

19. During the last 7 days did you have any special day (tea guests, chama, burial, wedding etc.), where you cooked more food than usual? (1=Yes, 0=No) _____
19.1 If yes to question 19, please specify (list number of people (adult/children)): _____ Number of days: _____

Questionnaire number (adda_hhid) _____

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)**				**Average price per purchased unit Ksh…**
				Own production	*Purchased*	*Gift*	*Other, specify*	
1	**Staple foods**							
2	Maize green							
3	Maize grain							
4	Maize flour							
5	Yam Tuber							
6	Yam flour							
7	Cassava Tuber							
8	Cassava flour							
9	Orange fleshed sweet potato							
10	Other sweet potato							
11	Irish potato							
12	Irish potato chips							
13	Arrowroots							
14	Sorghum grain							
15	Sorghum Flour							
16	Millet grain							
17	Millet flour							
18	Brown rice							
19	White rice							
20	Wheat grain							
21	Wheat flour brown							
22	Wheat flour white							
23	Cooking banana							
24	**Other staple foods**							
25								
26								
27								
28	**Vegetables**							
29	Amaranth leaves (Emboga)							
30	Black night shade (Rinagu)							
31	Butternut							
32	Cabbage							

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)**				**Average price per purchased unit Ksh…**
				Own production	*Purchased*	*Gift*	*Other, specify*	
33	Carrot							
34	Cow pea leaves							
35	Cucumber							
36	Eggplant							
203	Ginger							
37	Jute mallow (Omotere)							
38	Kales (Sukuma)							
39	Mushrooms							
40	Okra							
41	Onion							
42	Pepper/Capsicum (Hoho)							
204	Chili/Pepper							
43	Pumpkin							
44	Pumpkin leaves (Risosa)							
45	Spider plant (Chinsaga)							
46	Spinach							
47	Stinging nettle (rise)							
48	Sweet potato leaves							
49	Tomato							
50	Vine spinache (Enerema)							
51	**Other vegetables**							
52								
53								
54								
55	**Nuts and Pulses**							
200	KK 15 (fresh+dry)							
56	Beans dry							
57	Beans fresh							
58	Black Bean							
59	Cashew nut							

Code A																					
1	Liter	3	Teaspoon	6	Kg	9	10 kg bag	12	90 kg bag	16	Piece/Counts	19	1 kg tin	25	Pint (500 ml)	33	Black Paper Bag	77	Others Specify
2	Milliliter	4	Tablespoon	7	Gram	10	25 kg bag	13	Debe	17	¼ kg tin	21	Bundles	26	Gorogoro	34	Green Paper Bag	78	Others Specify
		5	Serving spoon	8	5 kg bag	11	50 kg bag	14	Bunch	18	½ kg tin	22	Handful	31	Cob	40	Stick	79	Others Specify

Questionnaire number (adda_hhid) _____

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)** *Own production*	*Purchased*	*Gift*	*Other, specify*	**Average price per purchased unit Ksh…**
60	Green grams							
61	Groundnut (boild)							
62	Groundnut (roasted)							
63	Lentils							
64	Peas (incl cowpea (Egesare), pigeon peas, green peas)							
65	Sesame seeds							
66	Soya meat							
67	Soybean							
68	Soybean flour							
69	**Other pulses and nuts**							
70								
71								
72								
73	**Fruits**							
74	Apple							
75	Avocado							
76	Coconut							
77	Guava							
78	Melon							
79	Orange							
80	Passion fruit							
81	Physalis/goose berry							
82	Pineapple							
83	Ripe bananas							
84	Ripe mango							
85	Ripe pawpaw							
86	Sugar cane							
87	**Other fruits**							
88								
89								
90								
91	**Meat and animal Products**							
92	Beef sausage							

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)** *Own production*	*Purchased*	*Gift*	*Other, specify*	**Average price per purchased unit Ksh…**
93	Bush meat (Game meat)							
201	Kuroiler Chicken							
94	Chicken							
95	Chicken sausage							
96	Cow meat							
202!	Kuroiler Eggs (pieces)							
97	Eggs (pieces)							
98	Fish							
99	Goat/ Sheep meat							
100	Liver (from any animal)							
101	Offal's (matumbo)							
102	Pork							
103	Sardine (dagaa)							
104	Termites							
105	Turkey (batamzinga)							
106	**Other meats**							
107								
108								
109								
110	**Dairy products**							
111	Cheese							
112	Ice cream							
113	Milk (cow/goat milk)							
114	Powdered milk							
115	Sour milk (mala)							
116	Yoghurt							
117	**Other dairy product**							
118								
119								
120								
121	**Beverages**							
122	Cocoa powder							

Code A		3	Teaspoon	6	Kg	9	10 kg bag	12	90 kg bag	16	Piece/Counts	19	1 kg tin	25	Pint (500 ml)	33	Black Paper Bag	77	Others Specify
1	Liter	4	Tablespoon	7	Gram	10	25 kg bag	13	Debe	17	¼ kg tin	21	Bundles	26	Gorogoro	34	Green Paper Bag	78	Others Specify
2	Milliliter	5	Serving spoon	8	5 kg bag	11	50 kg bag	14	Bunch	18	½ kg tin	22	Handful	31	Cob	40	Stick	79	Others Specify

Questionnaire number (adda_hhid) _____

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)** *Own production*	*Purchased*	*Gift*	*Other, specify*	**Average price per purchased unit Ksh…**
123	Coffee (powder)							
124	Drinking chocolate							
125	Milo powder							
126	Soya powder							
127	Tea (leaves)							
128	**Other beverages**							
129								
130								
131	**Drinks**							
132	Apple juice							
133	Bottled beer							
134	Local beer							
135	Orange juice							
136	Pineapple juice							
137	Other juice (concentrates)							
138	Soft drinks (coke/fanta/etc)							
139	Wine							
140	**Other drinks**							
141	Water (Drinking)							
142								
143	**Condiments and spices**							
144	Salt							
145	Curry (Powder							
146	Ginger (tangawizi; Powder)							
147	Ketchup, Tomato sauce							
148	Black Pepper (Powder)							
149	**Other Condiments and spices**							
150								
151								
152								

!!	14	15	16	17	17a	17b	17c	18
	Food Items consumed in the past 7 DAYS	**How much in total did your household consume during the last 7 days?**	**Unit of quantities consumed** *(Use codes above A)*	**Source (*record quantities*)** *Own production*	*Purchased*	*Gift*	*Other, specify*	**Average price per purchased unit Ksh…**
153	**Snacks (Bought ones, don't account into flour)**							
154	Bread							
155	Biscuit/cookies							
156	Popcorn							
157	Cakes							
158	Mandazi							
159	**Other snacks**							
160								
161								
162	**Sugar and sweets**							
163	Sugar							
164	Chocolate							
165	Honey							
166	Sweets							
167	**Other sugar and sweets**							
168								
169								
170	**Fat and Oil**							
171	Animal fat							
172	Butter							
173	Corn Oil							
174	Groundnut Oil							
175	Margarine							
176	Sunflower Oil							
177	Vegetable Oil							
178	Vegetables Fat							
179	**Other oil**							
180								
181								

Code A																			
1	Liter	4	Tablespoon	7	Gram	10	25 kg bag	13	Debe	17	¼ kg tin	21	Bundles	26	Gorogoro	34	Green Paper Bag	78	Others Specify
2	Milliliter	5	Serving spoon	8	5 kg bag	11	50 kg bag	14	Bunch	18	½ kg tin	22	Handful	31	Cob	40	Stick	79	Others Specify

Questionnaire number (adda_hhid) _____

TARGET PERSON: Mother or caretaker of child between the age of six to 59 months

MODULE 21: CHILD QUESTIONNAIRE – ONLY ONE CHILD WILL BE CONSIDERED

Respondent MEMID: _____

Please only ask this section to households that have children **under the age of 5 years**. Check first and probe if you are not sure! Ask the following questions to the person who is mainly responsible for the child care, e.g. mother, father, grandmother etc.)

If **NO** Child under 5 years is living in the household, please go to the next Module 22. If more than one child is under the age of 5 years, please choose the child of the group member. If not applicable choose child where respondent is available. If there is more than one child in the age range please choose randomly.

1	2	3a	3b	3c	4	5	6
MEMID of child	Name	Date of Birth *(please check with birth card; don't know=88)*			Age in month	Health card present? (No=0, Yes=1)	Which relationship to Child do you have? *(Respondent of this section, insert code below)* **Code A**
		Day	Month	Year			

Code A

1	Father	6	Stepfather/stepmother
2	Mother	7	Cousin
3	Grandmother/grandfather	8	Remote relative
4	Sister/brother	9	Care taker
5	Aunt/uncle	77	Others, specify_____

!

! !

PART 1: CHILD ANTHROPOMETRIC

In this section we would like to take the height, weight and mid-upper arm circumferences of your child. We will do this twice by two different enumerators to make sure to get the right weight and height.

1	1a	2	2a	3	3a	3b
Weight (kg)		Height (cm)		MUAC (measure tape)		
Data	Data	Data	Data	Data	Data	Data
!! !				!!	!!	!

'

Questionnaire number (adda_hhid) _____

PART 2: CHILD HEALTH SECTION

Please ask the parent/caretaker of the child the following questions.

1	Where did you give birth to this child? **A**	
2	Was the child a single or a multiple birth? *Single = 0, Twin = 1, Triple=3, Other, specify=77*	
3	What is the child's birth order e.g. was child born 1st, 2nd, 3rd, etc.?	
4	Please record here, if the child received the following vaccines: *(insert 0 if they did not receive," 1" if they did & have card, and a "2" if the mother says the child received but there is no card), don't know = 88* a Measles (at 9 month) c BCG (against tuberculosis) – at birth b Polio (OPV – at birth, 6wk, 10 wk and 14 wk) d DPT/DTaP (diphtheria, pertussis e.g. whooping cough and tetanus) (at 6wk, 10 wk and 14 wk)	
5	Has **the selected** child suffered from any of the following illnesses/symptoms in the *last 14 days*? Indicate for how long ____ days a Diarrhea d Fever g Blindness j Mouth problems b Measles e Fatigue/lethargy h Skin diseases k Eye disease c Anaemia f Respiratory illness i Pneumonia l Others, specify	
6	In the last year (1st Oct 2015 to 30th Sep 2016) did the child receive any of the following nutrition supplements or medical treatments (pills, liquids or supplemented food)? If YES, indicate for how long _____ days; if No=0, Don't Know=88 a Vitamin A (red/blue) b Iron c Iodine d Zinc (OLS)	
7	Has **[considered child]** ever been breastfed? No=0, Yes=1, Don't Know=88	
8	Was [**considered child]** given anything to drink or eat BEFORE the first breastfeed? No=0, Yes=1, Don't Know=88	
9	Is child still being **breastfed?** No=0, Yes=1, Don't Know=88	
10	If the child is not breastfed anymore, at what age (in month) was breastfeeding stopped? *(please record age in month)*	
11	At what age was [considered child] given **other food** apart from breast milk? *Please verify by asking other household members; please record age in month or if not sure = 88, or if child does not take food yet =99*	
12	What do you think is the recommended period of exclusive breastfeeding? *Define exclusive breastfeeding ,if unsure, fill in 88* – **Record Number of month**	
13	Which health problems or disease do you think are associated with **not exclusively breastfeeding**? *(Maximum 3 options) B*	**a** / **b** / **c**

Code A

1 Health facility
2 Home
3 En route to facility
4 Private hospital
6 Outside of home (e.g. in the field)
7 At another home (e.g. relative, neighbor)
8 Government hospital
77 Other, specify_____
88 Do not Know

Code B

1 Death
2 Low weight for height
3 Low height for age
4 Low weight
5 Stomach ache
6 Delayed achievement of development milestones (smiling, grabbing, etc)
7 Diarrhoea
8 Weakness
9 Low immunity
10 Obesity
77 Other, specify_____
99 None
88 DNK

Questionnaire number (adda_hhid) _____

PART 3 Child: Dietary Recall from YESTERDAY (24hr DR) ✎ INDICATE ONLY FOOD ITEMS

CHILD MEMID: _____

Now I would like to ask you about everything (including snacks) that (CHILD) ate yesterday during the day or night, whether at home or outside of the home.*Continue through the day, **until respondent indicates child went to sleep** until the next day. If respondent mentions a mixed dish like a porridge, relish or stew, ask about all ingredients that went into the dish, including added oil, sugar or condiments. **Probe for drinks & fruits**.*

1	Which day of the week does this record represent? **A**									
2	Is this a typical day? YES =1, NO=0					13. If NO, please specify:				
3		4	5	6	7	8	9	10	11	12
Main Dish		**Quantity**	**Unit -D**	How was the **dish** prepared-**C**	**Ingredients**	**Quantity**	**Unit -D**	Source of Ingredients **B**	No of People ate from the Main Dish	Where was the food consumed? **- E**
Breakfast										
Snack										
Lunch										
Snack										
Dinner										
Snack										

Code A		4	Thursday	**Code B**		4	Rain Water	**Code C**		5	Cooked	**Code E**		5	Market
1	Monday	5	Friday	1	Own production	5	Spring Water	1	Raw	6	Fried	1	Home	6	School
2	Tuesday	6	Saturday	2	Purchased	6	Well	2	Dried	7	Roasted	2	Hotel	7	Ceremony
3	Wednesday	7	Sunday	3	Gift	7	Borehole	3	Boiled	8	Processed	3	Friend	77	Other, specify____
						77	Other, Specify	4	Steamed	77	Other, specify	4	Work		
Code D		3	Tablespoon	6	Pinch	9	Serving spoon	13	Glass	21	Slice	25	Bowl	77	Other, specify____
1	Small cup	4	Grams	7	Ml	10	Piece	16	Bundle	23	Cobs	26	Handful		
2	Teaspoon	5	Liter	8	Pint (500ml)	12	Cup	17	Kg	24	Plates	40	Stick		

Questionnaire number (adda_hhid) _____

MODULE 22: INDIVIDUAL PART

Respondent MEMID _____

Name: _____

MODULE 22/1- FIRST INDIVIDUAL QUESTIONNAIRE (1)

This section will be answered by one chosen individual of the household, e.g. individual which is mentioned in the information sheet.

This module will be asked at two different days. Additionally, we would like to measure the respondent (weight, height, hip and waist). Please tell the respondent the date of the second visit.

Please make sure that the same person on both days is answering the questionnaire.

PART 3: INDIVIDUAL 1 - ANTHROPOMETRIC

In this section we would like to take the height and weight of you. We will do this twice by two different enumerators to make sure to get the right weight and height.

1	2	2a	3	3a	4	5
Type of clothe (light=0, heavy=1)	Weight (kg)		Height (cm)		Waist	Hip
	Data	Data	Data	Data	cm	cm
!			!!	!!	!!	! ! !

!

Questionnaire number (adda_hhid) _____

PART 1 First Individual Dietary Recall for YESTERDAY (1) (24hr DR) ✎ Record Day_____

Respondent MEMID: _____

*Now we would like to know, which food and drinks and how much of it did you alone (not your household) consume yesterday. Please indicate food item, preparation and sourc. Write down all the foods, **drinks** and **fruits** mentioned. When mixed dishes are mentioned, ask for the list of ingredients. When the respondents has finished, probe for the meals and snacks not mentioned.*

1	Which day of the week does this record represent? **A**									
2	Is this a typical day? YES =1, NO=0					13. If NO, please specify:				
3		4	5	6	7	8	9	10	11	12
Main Dish		**Quantity**	**Unit-D**	How was the **dish** prepared-**C**	**Ingredients**	**Quantity**	**Unit-D**	Source of Ingredients **B**	No of People ate from the Main Dish	Where was the food consumed? - **E**
Breakfast										
Snack										
Lunch										
Snack										
Dinner										
Snack										

Code A				**Code B**				**Code C**				**Code E**			
1	Monday	5	Friday	1	Own production	5	Spring Water	1	Raw	6	Fried	1	Home	6	School
2	Tuesday	6	Saturday	2	Purchased	6	Well	2	Dried	7	Roasted	2	Hotel	7	Ceremony
3	Wednesday	7	Sunday	3	Gift	7	Borehole	3	Boiled	8	Processed	3	Friend	77	Other, specify____
						77	Other, Specify	4	Steamed	77	Other, specify	4	Work		
Code D															
1	Small cup	3	Tablespoon	6	Pinch	9	Serving spoon	13	Glass	21	Slice	25	Bowl	77	Other, specify____
2	Teaspoon	4	Grams	7	Ml	10	Piece	16	Bundle	23	Cobs	26	Handful		
		5	Liter	8	Pint (500ml)	12	Cup	17	Kg	24	Plates	40	Stick		

Questionnaire number (adda_hhid) _____

Second visit (Day 2) **PART 2: First Individual: Dietary Recall for YESTERDAY (2) (24hr DR)**

Record Day_____ **Respondent MEMID:** _____

*Now we would like to know, which food and drinks and how much of it did you alone (not your household) consume yesterday. Please indicate food item, preparation and sourc. Write down all the foods, **drinks** and **fruits** mentioned. When mixed dishes are mentioned, ask for the list of ingredients. When the respondents has finished, probe for the meals and snacks not mentioned.*

1	Which day of the week does this record represent? **A**									
2	Is this a typical day? YES =1, NO=0					13. If NO, please specify:				
3		4	5	6	7	8	9	10	11	12
Main Dish		**Quantity**	**Unit -D**	How was the **dish** prepared-**C**	**Ingredients**	**Quantity**	**Unit -D**	Source of Ingredients **B**	No of People ate from the Main Dish	Where was the food consumed? - **E**
Breakfast										
Snack										
Lunch										
Snack										
Dinner										
Snack										

Code A				**Code B**				**Code C**				**Code E**			
1	Monday	5	Friday	1	Own production	5	Spring Water	1	Raw	6	Fried	1	Home	6	School
2	Tuesday	6	Saturday	2	Purchased	6	Well	2	Dried	7	Roasted	2	Hotel	7	Ceremony
3	Wednesday	7	Sunday	3	Gift	7	Borehole	3	Boiled	8	Processed	3	Friend	77	Other, specify____
						77	Other, Specify	4	Steamed	77	Other, specify	4	Work		
Code D															
1	Small cup	3	Tablespoon	6	Pinch	9	Serving spoon	13	Glass	21	Slice	25	Bowl	77	Other, specify____
2	Teaspoon	4	Grams	7	Ml	10	Piece	16	Bundle	23	Cobs	26	Handful		
		5	Liter	8	Pint (500ml)	12	Cup	17	Kg	24	Plates	40	Stick		

Questionnaire number (adda_hhid) _____

Code A

1	very good	2	Good	3	not good/not poor	4	a little poor	5	very poor	88	DNK

Code B

1	Asthma	3	Cardiovascular disease	4	Diabetes	5	Hypertension	77	Other, specify_
88	DNK	99	None						

Code C

1	Bad teeth (ache)	5	Eye problems	9	Headache	13	Malaria	17	Stomach ache	21	Vomiting
2	Cholera	6	Fainting	10	Hepatitis	14	Measles	18	Tetanus	22	Weakness
3	Diarrhea	7	Fever	11	High cholesterol	15	Pneumonia	19	Tiredness/Fatigue	77	Other, specify__
4	Ear/throat problem	8	Flu/Cold	12	Intestinal worms	16	Skin Problem	20	Tuberculosis	99	None

Code D

1	Fatigue, tiredness	3	Weak immune system	5	Reduction in intelligence	7	Soreness of the moth	77	Other, specify____
2	Low concentration	4	Shortage of blood	6	Small stature	8	Unusual quantity of hair loss	88	DNK

Code E

1	Green leafy vegetables	3	Soybean/chick peas/ lentils	5	Fish	7	Liver	77	Other, specify
2	Peas	4	Meat	6	orange/red coloured fruits & vegetables (eg., OFSP, tomatoes)			88	DNK

Code F

1	leading to eye blindness	2	Night blindness	3	Measles	4	Diarrhea	5	Worms
77	Other, specify_	88	DNK						

Code G

1	Green leafy vegetables	3	Milk & milk products	5	Eggs	77	Other, specify_		
2	Orange vegetables & fruits	4	Palm Oil	6	Offal's	88	DNK		

Code H

1	Iodine	3	Vitamin A	5	Zinc	77	Other specify	99	None
2	Iron	4	Vitamin C			88	DNK		

Code J

1	**Beans**	3	Cheese	5	Dairy products	7	Fish	9	Sardines	77	Other, specify
2	Beef	4	Chicken	6	Eggs	8	Milk	10	Yoghurt	88	DNK

Code K -

1	Chapatti	3	Cassava	5	Crips	7	Plantain	9	Ugali	88	DNK
2	Bread	4	Yam	6	Potato	8	Rice	77	Other, specify		

Code L

1	Butter	3	Lard	5	Oil	77	Other, specify
2	Groundnuts	4	Kimbo	6	Palm Oil	88	DNK

Code M

1	Radio	4	Doctor	7	Health centre	10	School	77	Other Specify
2	TV	5	**Nutrition education (specify)**	8	Internet	11	Community health worker	88	DNK
3	**NGO (specify:____)**	6	Newspaper	9	Friends/Relatives	12	Church		

Code N

1	Hypertension	3	Diabetes	5	High cholesterol
2	Cardiovascular diseases	4	Cancer	77	Others, specify

Code O

1	Respondent	3	House help	5	Sister	7	Daughter	9	Respindent + Spouse	77	Other specify:
2	Spouse	4	Brother	6	Grandparents	8	Son	10	Whole family	99	N/A

Questionnaire number (adda_hhid) _____

PART 2 First Individual: INDIVIDUAL KNOWLEDGE QUESTIONS - second visit (Day 2)

Respondent MEMID: _____

1	During the last 4 weeks how would you rate your health? **A**				
2	Do you suffer from any of the following diseases _____ **[Read out Code B]**				
3	Have you suffered from any diseases or symptoms during the last 30 days? *Allow up to four answers* **C**	a	b	c	d
4	Can you name anything that helps prevent you and other family members from getting diarrhea? Yes=1, No=0, ***If No, skip to question 5***_____. If yes, let respondent specify and tick the ones that apply underneath – *do not read out the list, probe for further responses – more than one answer possible* a Washing hands c Exclusive breast feeding e Other specify b Use latrine/ bury faces d Protect food & water supplies with cover				
5	Which diseases or problems are caused by deficiency in iron?*(allow up to3 answers- **Do not prompt**)* **D**	a	b	**c**	
6	Do you know which foods have ample amounts of iron? *(allow up to3 answers – **Do not prompt**)* **E**	a	b	**c**	
7	Which diseases or problems are caused by deficiency in vitamin A? *(allow up to3 answers – **Do not prompt**)* **F**	a	b	**c**	
8	Do you know which foods have ample amounts of vitamin A? *(allow up to3 answers – **Do not prompt**)* **G**	a	b	**c**	
10	Did [NAME] receive any nutritious supplements in the last year (Oct 15 – Sept 16)? *Multiple answer possible, allow up to 3 answers* **H**	a	b	c	
11	Who do you think is the most informed person within your household concerning nutrition information? **ENTER MEMID**				
12	Who do you think is the most informed person within your household concerning agricultural information? **ENTER MEMID**				
13	Have you heard of the following macronutrients: *No=0, Yes=1; If no, please go to question 24*	a Protein	b Carbohydrates	c Fat	
14	If yes, to question 20, please name which food items can supply those macronutrients: *(allow up to three answers)*		a	b	c
15		Protein **J**			
16		Carbohydrates **K**			
		Fat **L**			
19	During the last year (Oct. 2015 - Sept 2016), have you noticed or received information/training about healthy eating or healthy diets? *No=0, Yes=1 (If NO, skip to next M23)*				
20	If yes, where did you find, see or get this information on healthy eating/diet? **M**				
21	Are you aware of any health problems or diseases that are associated with excess weight? *Yes = 1 No = 0 Don't know = 88*				
22	Which diseases do you think are associated with excess weight? *(Allow up to three responses. Rank according to likelihood)* **N**	1	2	3	

Modul 23/1: Decision making

		Code O	Fill in MEMID
1	Who decides how the household finances should be allocated?		
2	Who manages the household finances and implements the decision?		
3	Who makes the decision **which** food is purchased in the household?		
4	If not the respondent, please ask if the respondent would prefer other food to be purchased. YES=1, NO=0		
5	Who makes the decision **where** food is purchased in the household?		
6	If not the respondent, please ask if the respondent would prefer that the food would be purchased somewhere else? YES=1, NO=0		
7	Who decides which and how much food is consumed from your own produce?		
8	Who is responsible to purchases food on a daily basis?		
9	Who makes the decision which food is prepared in the household?		
10	Who is responsible for daily food preparation in the household?		
11	Who makes decisions on expenditure on cheap household assets?		
12	Who males decisions on expenditure on expensive household assets?		
13	Who makes decisions on medical expenditures?		
14	Who makes decisions on education?		
15	Who decides to participate in agricultural training sessions?		

Questionnaire number (adda_hhid) _____

Module 22: Individual Part

Respondent MEMID _____

Name: _____

MODULE 22/2- SECOND INDIVIDUAL QUESTIONNAIRE (2)

This section will be answered by one chosen individual of the household,e.g the second individual on the information sheet given.

This module will be asked at two different days. At the first visit one 24-hour dietary recall will be asked. On the second visit a second 24 hour dietary recall and nutrition/health knowledge questions will be asked. Additionally, we would like to measure the respondent (weight, height, hip and waist). Please make an appointment with the respondent to come back after at least two days. Please make sure that the same person on both days is answering the questionnaire.

PART 3: INDIVIDUAL 2 ANTHROPOMETRIC						
In this section we would like to take the height, weight of you. We will do this twice by two different enumerators to make sure to get the right weight and height.						
1	2	2a	3	3a	4	5
Type of clothe (light=0, heavy=1)	Weight (kg)		Height (cm)		Waist	Hip
	Data	Data	Data	Data	cm	cm
!			!!	!!	!!	! ! !

Questionnaire number (adda_hhid) _____

PART 1 Second Individual: Dietary Recall for YESTERDAY (1) (24hr DR) ✎ Record Day

Respondent MEMID:_____

*Now we would like to know, which food and drinks and how much of it did you alone (not your household) consume yesterday. Please indicate food item, preparation and sourc. Write down all the foods, **drinks** and **fruits** mentioned. When mixed dishes are mentioned, ask for the list of ingredients. When the respondents has finished, probe for the meals and snacks not mentioned.*

1	Which day of the week does this record represent? **A**									
2	Is this a typical day? YES =1, NO=0					13. If NO, please specify:				
3	4	5	6		7	8	9	10	11	12
Main Dish	**Quantity**	**Unit -D**	How was the **dish** prepared-**C**		**Ingredients**	**Quantity**	**Unit -D**	Source of Ingredients **B**	Nb of People eaten from Main Dish	Where was the food consumed? - **E**
Breakfast										
Snack										
Lunch										
Snack										
Dinner										
Snack										

Code A				**Code B**				**Code C**				**Code E**			
1	Monday	4	Thursday	1	Own production	4	Rain Water	1	Raw	5	Cooked	1	Home	5	Market
2	Tuesday	5	Friday	2	Purchased	5	Spring Water	2	Dried	6	Fried	2	Hotel	6	School
3	Wednesday	6	Saturday	3	Gift	6	Well	3	Boiled	7	Roasted	3	Friend	7	Ceremony
		7	Sunday			7	Borehole	4	Steamed	8	Processed	4	Work	77	Other, specify____
Code D						77	Other, Specify			77	Other, specify				
1	Small cup	3	Tablespoon	6	Pinch	9	Serving spoon	13	Glass	21	Slice	25	Bowl	77	Other, specify____
2	Teaspoon	4	Grams	7	Ml	10	Piece	16	Bundle	23	Cobs	26	Handful		
		5	Liter	8	Pint (500ml)	12	Cup	17	Kg	24	Plates	40	Stick		

Questionnaire number (adda_hhid) _____

Second visit (Day 2) **PART 2Second Individual: Dietary Recall for YESTERDAY (2) (24hr DR)**

Record Day_____ **Respondent MEMID:**_____

*Now we would like to know, which food and drinks and how much of it did you alone (not your household) consume yesterday. Please indicate food item, preparation and sourc. Write down all the foods, **drinks** and **fruits** mentioned. When mixed dishes are mentioned, ask for the list of ingredients. When the respondents has finished, probe for the meals and snacks not mentioned.*

1	Which day of the week does this record represent? **A**									
2	Is this a typical day? YES =1, NO=0					13. If NO, please specify:				
3	4	5	6	7		8	9	10	11	12
Main Dish	**Quantity**	**Unit -D**	How was the **dish** prepared-**C**	**Ingredients**		**Quantity**	**Unit -D**	Source of Ingredients **B**	Nb of People eaten from Main Dish	Where was the food consumed? - **E**
Breakfast										
Snack										
Lunch										
Snack										
Dinner										
Snack										

Code A				**Code B**				**Code C**				**Code E**			
1	Monday	4	Thursday	1	Own production	4	Rain Water	1	Raw	5	Cooked	1	Home	5	Market
2	Tuesday	5	Friday	2	Purchased	5	Spring Water	2	Dried	6	Fried	2	Hotel	6	School
3	Wednesday	6	Saturday	3	Gift	6	Well	3	Boiled	7	Roasted	3	Friend	7	Ceremony
		7	Sunday			7	Borehole	4	Steamed	8	Processed	4	Work	77	Other, specify_____
Code D															
1	Small cup	3	Tablespoon	6	Pinch	9	Serving spoon	13	Glass	21	Slice	25	Bowl	77	Other, specify_____
2	Teaspoon	4	Grams	7	Ml	10	Piece	16	Bundle	23	Cobs	26	Handful		
		5	Liter	8	Pint (500ml)	12	Cup	17	Kg	24	Plates	40	Stick		

Questionnaire number (adda_hhid) _____

Code A

1	very good	2	Good	3	not good/not poor	4	a little poor	5	very poor	88	DNK

Code B

1	Asthma	3	Cardiovascular disease	4	Diabetes	5	Hypertension	77	Other, specify_
88	DNK	99	None						

Code C

1	Bad teeth (ache)	5	Eye problems	9	Headache	13	Malaria	17	Stomach ache	21	Vomiting
2	Cholera	6	Fainting	10	Hepatitis	14	Measles	18	Tetanus	22	Weakness
3	Diarrhea	7	Fever	11	High cholesterol	15	Pneumonia	19	Tiredness/Fatigue	77	Other, specify__
4	Ear/throat problem	8	Flu/Cold	12	Intestinal worms	16	Skin Problem	20	Tuberculosis	99	None

Code D

1	Fatigue, tiredness	3	Weak immune system	5	Reduction in intelligence	7	Soreness of the moth	77	Other, specify____
2	Low concentration	4	Shortage of blood	6	Small stature	8	Unusual quantity of hair loss	88	DNK

Code E

1	Green leafy vegetables	3	Soybean/chick peas/ lentils	5	Fish	7	Liver	77	Other, specify
2	Peas	4	Meat	6	orange/red coloured fruits & vegetables (eg., OFSP, tomatoes)			88	DNK

Code F

1	leading to eye blindness	2	Night blindness	3	Measles	4	Diarrhea	5	Worms
77	Other, specify_	88	DNK						

Code G

1	Green leafy vegetables	3	Milk & milk products	5	Eggs	77	Other, specify_		
2	Orange vegetables & fruits	4	Palm Oil	6	Offal's	88	DNK		

Code H

1	Iodine	3	Vitamin A	5	Zinc	77	Other specify	99	None
2	Iron	4	Vitamin C			88	DNK		

Code J

1	**Beans**	3	Cheese	5	Dairy products	7	Fish	9	Sardines	77	Other, specify
2	Beef	4	Chicken	6	Eggs	8	Milk	10	Yoghurt	88	DNK

Code K -

1	Chapatti	3	Cassava	5	Crips	7	Plantain	9	Ugali	88	DNK
2	Bread	4	Yam	6	Potato	8	Rice	77	Other, specify		

Code L

1	Butter	3	Lard	5	Oil	77	Other, specify
2	Groundnuts	4	Kimbo	6	Palm Oil	88	DNK

Code M

1	Radio	4	Doctor	7	Health centre	10	School	77	Other Specify
2	TV	5	**Nutrition education (specify)**	8	Internet	11	Community health worker	88	DNK
3	**NGO (specify:_____)**	6	Newspaper	9	Friends/Relatives	12	Church		

Code N

1	Hypertension	3	Diabetes	5	High cholesterol
2	Cardiovascular diseases	4	Cancer	77	Others, specify

Code O

1	Respondent	3	House help	5	Sister	7	Daughter	9	Respindent + Spouse	77	Other specify:
2	Spouse	4	Brother	6	Grandparents	8	Son	10	Whole family	99	N/A

Questionnaire number (adda_hhid) _____

PART 2 Second Individual: INDIVIDUAL KNOWLEDGE QUESTIONS - second visit (Day 2)

Respondent MEMID: _____

1	During the last 4 weeks how would you rate your health? **A**				
2	Do you suffer from any of the following diseases _____ **[Read out Code B]**				
3	Have you suffered from any diseases or symptoms during the last 30 days? *Allow up to four answers* **C**	a	b	c	d
4	Can you name anything that helps prevent you and other family members from getting diarrhea? Yes=1, No=0, ***If No, skip to question 5***_____. If yes, let respondent specify and tick the ones that apply underneath – *do not read out the list, probe for further responses – more than one answer possible* a Washing hands c Exclusive breast feeding e Other specify b Use latrine/ bury faces d Protect food & water supplies with cover				
5	Which diseases or problems are caused by deficiency in iron? *(allow up to3 answers- **Do not prompt**)* **D**	a	b	**c**	
6	Do you know which foods have ample amounts of iron? *(allow up to3 answers – **Do not prompt**)* **E**	a	b	**c**	
7	Which diseases or problems are caused by deficiency in vitamin A? *(allow up to3 answers – **Do not prompt**)* **F**	a	b	**c**	
8	Do you know which foods have ample amounts of vitamin A? *(allow up to3 answers – **Do not prompt**)* **G**	a	b	**c**	
10	Did [NAME] receive any nutritious supplements in the last year (Oct 15 – Sept 16)? *Multiple answer possible, allow up to 3 answers* **H**	a	b	c	
11	Who do you think is the most informed person within your household concerning nutrition information? **ENTER MEMID**				
12	Who do you think is the most informed person within your household concerning agricultural information? **ENTER MEMID**				
13	Have you heard of the following macronutrients: *No=0, Yes=1; If no, please go to question 24*	a Protein	b Carbohydrates	c Fat	
14	If yes, to question 20, please name which food items can supply those macronutrients: *(allow up to three answers)*		a	b	c
15		Protein **J**			
16		Carbohydrates **K**			
		Fat **L**			
19	During the last year (Oct. 2015 - Sept 2016), have you noticed or received information/training about healthy eating or healthy diets? *No=0, Yes=1 (If NO, skip to next M23)*				
20	If yes, where did you find, see or get this information on healthy eating/diet? **M**				
21	Are you aware of any health problems or diseases that are associated with excess weight? *Yes = 1 No = 0 Don't know = 88*				
22	Which diseases do you think are associated with excess weight? *(Allow up to three responses. Rank according to likelihood)* **N**	1	2	3	

Modul 23/1: Decision making

		Code O	Fill in MEMID
1	Who decides how the household finances should be allocated?		
2	Who manages the household finances and implements the decision?		
3	Who makes the decision **which** food is purchased in the household?		
4	If not the respondent, please ask if the respondent would prefer other food to be purchased. *YES=1, NO=0*		
5	Who makes the decision **where** food is purchased in the household?		
6	If not the respondent, please ask if the respondent would prefer that the food would be purchased somewhere else? *YES=1, NO=0*		
7	Who decides which and how much food is consumed from your own produce?		
8	Who is responsible to purchases food on a daily basis?		
9	Who makes the decision which food is prepared in the household?		
10	Who is responsible for daily food preparation in the household?		
11	Who makes decisions on expenditure on cheapl household assets?		
12	Who males decision on expenditure on expensive household assets?		
13	Who makes decisions on medical expenditures?		
14	Who makes decisions on education?		
15	Who decides to participate in agricultural training sessions?		