

EXAMINING THE NUTRITIONAL DIETARY INTAKE OF WOMEN AND  
CHILDREN IN NIGER

A Dissertation

by

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## ABSTRACT

Nutrient-rich foods and diverse diets are key elements for optimal health. The majority (98%) of undernourished people reside in under developed countries; resulting in high rates of maternal and child mortality. The stunting rate of children in Niger is over 50% percent, one of the highest in the world. Purpose: The purpose of the dissertation were 1) to comprehensively examine the literature to evaluate dietary diversity of women and children in Sub-Saharan Africa 2) to describe and explore the predicting factors of dietary diversity among children aged 0 to 24 months of age in Niger 3) describe and explore the predicting factors of dietary diversity among reproductive women (15-49 years of age).

This study implemented quantitative methods to investigate dietary intake among women and children. The first study is a comprehensive review was on the dietary diversity of women and children in SSA were conducted. The second study is a cross sectional study was conducted to examine children dietary diversity, and the maternal factors that impact children dietary diversity. In the third study, a cross sectional study was conducted to examine the predicting factors of dietary diversity among women of reproductive age (15-49 years of age).

Study one found that women and children lack dietary diversity in SSA. In study two children dietary diversity was low. Factors such as region, children's age, women empowerment, and vitamin A intake and wealth index were significant predictors of CDD. In study three, women's dietary diversity was low. The mean women dietary diversity was

3.5 in Zinder compared to 2.5 in Maradi ( $p < .05$ ). Region, household hunger scale, total number of eligible farmers and average household dietary diversity score were all strong predictors of women dietary diversity.

The findings of our studies provide important knowledge on the dietary diversity of women and children in Niger. Multi sector interventions to improve nutritional diversity for women and their children are needed in order to combat malnutrition in Niger.

## DEDICATION

This dissertation is dedicated to the women and children of Niger. Your bravery, and resilience to overcome obstacles in order to take care of your children is remarkable. To my twin mothers (Hassana and Ousseina Alidou), and my amazing husband (Chisom), your unconditional love and support has molded me into the woman I am today.

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# CHAPTER I

## INTRODUCTION AND RATIONALE

### **MALNUTRITION IN SUB-SAHARAN AFRICA (SSA)**

Nutritious foods and diverse diets are important factors for optimal health (World Health Organization [WHO], 2016a). According to WHO (2016a), a healthy diet not only helps to protect against malnutrition, it also prevents the onset of chronic diseases, heart disease, diabetes and cancer. Presently, approximately 793 million people are malnourished globally (Food and Agriculture Organization [FAO], 2016a).

The majority (98%) of malnourished people reside in under developed countries located in SSA (Fanzo, 2012). Approximately, one in four people in SSA are undernourished, this results in over 204 million people experiencing some form of malnourishment (Bain et al., 2014). Nutrition is a severely neglected component of maternal, infant and child health (Bain et al., 2014). In 2008, globally, maternal and child malnutrition caused approximately 3.5 million deaths and 35% of disease burden in children younger than 5 years of age (Black et al., 2008).

Maternal and child malnutrition remains a critical public health problem in SSA. Although the prevalence rate of low BMI among adult women in SSA has declined, the prevalence rate is still higher than 10% in the region (Black et al., 2008). Furthermore, roughly 100 million children in developing countries are underweight (WPF, 2016a).

The long term impact of malnutrition in women and children cannot be overemphasized. Malnutrition cripples women's ability to survive labor, renders them

more defenseless against sicknesses, undermine their capacity to work, and to properly tend to their families (Ahmend, Hossain & Sanin, 2012). In addition, women with short stature are more likely to have assisted delivery compared to those with average to higher stature due to cephalopelvic disproportion (Black et al., 2008). Studies have also found an association with maternal low body mass index and intrauterine growth restrictions (Fishman et al., 2004; Stoltzfus, Mullany, Black et al., 2004; Caufield et al., 2006; Black et al., 2008). Lastly, infant absorption of some micronutrients (vitamin A, iodine, thiamin, riboflavin, pyridoxine, and cobalamin) in breast milk is exclusively reliant on the mother's consumption (Black et al., 2008). Maternal intake of these supplements increases the levels in breast milk. This can enhance and improve the health status of infants (Black et al., 2008).

Malnutrition in children is common in SSA and is associated with limited stature and prolonged irreversible health outcomes (Caufield et al., 2006). According World WHO (2016b) malnutrition is estimated to contribute to more than 33% of child mortality, in spite of the fact that it is not frequently reported as the immediate cause of death. Typical causes of malnutrition are the lack of nutritious foods, due to food insecurity, and high food prices (Muller & Krawinkel, 2005).

Furthermore, studies have found that poor feeding practices, such as inadequate breast feeding, providing the wrong foods, and not guaranteeing that the child obtains enough food lead to malnutrition (Lutter et al., 2011; Kimani-Murage et al., 2011; Buskens, Jafee, Mkhathshwa, 2007; Kalanda, Verhoeff, & Brabin, 2006). Lastly, lack of healthy nutritious foods contributes to frequent and persistent infection with diarrhea,

pneumonia, and measles among children (WHO, 2016b).

To combat the global epidemic of malnutrition, in 2015 the United Nations (U.N.) implemented 17 goals known as the Sustainable Development Goals (SDG). These goals were designed to end poverty, hunger, eradicate disease, fight inequality and address climate change by 2030. SDG2’s aim is to “end hunger, achieve food security and improve (d) [nutrition, and promote sustainable agriculture.” SDG2 targets 5 specific goals (see table 1).The U.N. argues that in order to achieve the overall scope of the SDGs, progress in the reduction and elimination of hunger and malnutrition needs to be a paramount political agenda for global leaders (U.N., 2016).

**Table 1: SDG2 - Goal 2 targets (U.N., 2016)**

2.1	By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.
2.2	By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons
2.3	By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
2.4	By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

**Table 1: Continued**

2.5	By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.
2.a	Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.
2.b	Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round.
2.c	Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

Note: Reprinted from Sustainable Development Knowledge Platform by United Nations

## **OVERVIEW OF AGRICULTURE IN SSA AND FOOD PRODUCTION IN NIGER**

While, SSA is the region with the most natural resources in the world, presently it is the poorest in the world (Chauvin, Mulangu & Porto, 2012). Although, economic growth increased moderately in the region from 4.2% to 4.6% in 2014 (World Bank, 2016), presently, the gross national income in SSA is \$1,638 per year, which ranks it as the lowest in the world (World Bank, 2016). This long-term limited growth has contributed to high levels of poverty, and instability within the region (World Bank, 2016). This growth stagnation can be observed in the economic structures of all African countries (World Bank, 2016).

At present, SSA's economic structure is primarily dominated by its agriculture and minerals sectors (Chauvin, Mulangu & Porto, 2012). Unfortunately the agriculture sector is weakened due to the limited application of new technologies and science; while the mining sector utilizes modern technology from foreign investors which provides a notable impact on the rest of the region's economies (Chauvin, Mulangu & Porto, 2012; FAO, 2011a). Nevertheless, despite the foreign investments in mining, the agriculture sector is still the main contributor to the Gross Domestic Product (GDP) of SSA (Chauvin, Mulangu & Porto, 2012; FAO, 2011a). Unfortunately, the agriculture sector's productivity has lingered significantly behind that of different regions such as South Asia and Latin America, and has hampered the potential that SSA can reach in the world (Chauvin, Mulangu & Porto, 2012; FAO, 2011a).

SSA has the essential fertile land and labor to be food independent, however

there are three agriculture barriers that hinder this independence: adequate water, fertilizers, and technology (Chauvin, Mulangu & Porto, 2012). In SSA agriculture is mainly dependent on rain, making it vulnerable to delayed rainfall seasons, and droughts (FAO, 2011b). The agriculture sector is also liable to encounter lengthy droughts, and/or flooding during the raining season (FAO, 2011b). Climate change is expected to negatively impact agriculture, by decreasing the regions suitable for agribusiness, altering the length of the growing season and diminishing crop potential yield (Kotir 2011; Thornton, Jones, Ericksen, and Challinor 2011a).

According to the World Bank (2009), SSA is vulnerable to climate change due to its massive geographic difference in the availability of water, sub-tropic regions only receive rainfall during the rainy seasons, and semiarid and arid regions rely heavily on the rainy season. The majority of crop production and animal production is conducted in semi-arid regions (Thornton, Steeg, Herrero, 2009).

Furthermore, because food production is mostly produced by small farmers there is limited availability and use of fertilizers. From 2006 thru 2008 in SSA fertilizer utilization was approximately 11 kilogram per hectare of arable land, while the global average was roughly 123 kilograms (Shapori & Rosen, 2012). The utilization levels in SSA were low, even when compared to other developing countries standards, globally low income nations averaged more than 19 kilograms. The contributing factors too little utilization of fertilizers are price, limited access to loans, and foreign exchange difficulties for importing nations (Shapiro & Sander, 1998; Shapori & Rosen, 2012). Additionally, fertilizer effectiveness is weak in several developing countries due to the



circumstances and environment in which the fertilizer is used (Shapiro & Sander, 1998; Shapori & Rosen, 2012). The utilization of fertilizer is mainly efficient on damp and irrigated land, therefore African countries in semiarid climates must depend on the proper timing of rainfall (Shapori & Rosen, 2012).

According to Burney, Naylor and Postel (2013), in SSA only 4% of farming land is irrigated. In spite of the fact that around 40 million hectare are suitable for irrigation, just 7.3 million hectare are used, and the massive part of this irrigated area is centered in just 4 nations: Madagascar, Nigeria, South Africa and Sudan. Although studies have found that accomplishing food security and independence in SSA is a multifaceted exertion, studies have also demonstrated from regions to households that availability of water particularly for irrigation system has the possibility of decreasing hunger (Baro, Deubel, 2006; Viala, 2008; Burney et al., 2013).

## **FOOD PRODUCTION IN NIGER: CLIMATE, STAPLE FOODS AND ANIMAL FOODS**

### ***Climate***

Niger's climate is one of the hottest in the world, 75% of its surface is desert. Due to repeated droughts contributing to decreased agriculture production Niger has encountered several critical food insecurity crisis (Famine Early Warning Systems Network, 2016). From 1980-2010, Niger has experienced seven droughts (World Bank, 2013). In 2005, because of a severe drought, early end of the rainy season and locust infestation the national cereal production decreased by 9%. The rural regions were most impacted regions, whereby cereal production rates fell from 55% to 90% (Cornia &

Deotti, 2008).

### ***Staple foods***

In Niger approximately 15% of the land is available for cultivation and is located in the southern regions (Famine Early Warning Systems Network., 2016). Among the different types of cereal, pearl millet and sorghum are the most essential ones from the perspective of cultivation and food security. The conventional cereals, millets and sorghum embody approximately 85% of the overall food production in Niger, and produced on approximately two thirds of total arable land (International Food Policy Research Institute, 2016).

Pearl millet is cultivated in regions where the annual rainfall range is 250 to 650 mm (Niamey capital district, Tillaberi region, Maradi region, Tahoua region, and Zinder region) (International Food Policy Research Institute, 2013). Sorghum is also cultivated at the start of the rainy season and harvested during October. It is farmed in the regions of Niamey, Dosso and Maradi where the rainfall is much higher (International Food Policy Research Institute, 2013). Unfortunately, Sorghum is more vulnerable to striga than pearl millet, because it has a much lengthier duration of cultivation (International Food Policy Research Institute, 2016).

According to the FAO (2015c) crop pest infestations, striga and fungal disease are persistent barriers in the cultivation of most crops. Millet and sorghum embody 80–90% of the food intake of the population (International Food Policy Research Institute, 2016). Crops such as groundnuts and cowpeas are cultivated as intercrop with sorghum and millet. In addition, rice and maize are farmed in regions (Dossa and Maradi regions)

that has readily available water. The production of vegetables is mostly produced by family farmers during the dry season (Pretty, Morrison & Hine, 2003).

### *Animal foods*

Due to the uncertainty and fluctuation of weather conditions that crop producers face, some of the farmers in Niger rely on livestock production (FAO, 2006d).

Livestock production is conducted by approximately 87% of the active population as their primary activity, or secondary activity after farming (FAO, 2006d). Presently, Niger has the biggest animal population (10.5 million livestock) in the Sahel region (Economic Community of West African States (ECOWAS), 2008).

In the past 50 years, it is estimated that Niger's national herd have increased at a yearly rate of 2.47% (FAO, 2006d). According to ECOWAS (2008) repeated weather conditions and other disasters have negatively impacted herd survival and productivity in Niger. For example, from 1969-1974 Niger faced a massive drought that contributed to significant losses of herds (50 % of the cattle, 36 % of the sheep, and 27 % of the goats) (FAO, 2006d). In 2005 due to drought and locust infestation food production was low, contributing to a livestock feed deficits of 4,642,219 tons (The Humanitarian Response Index, 2007). Unfortunately, increased risks of climate change can decrease the amount of grassland each year, preventing countries like Niger from becoming meat independent (International Food Policy Research Institute, 2013).

## JUSTIFICATION OF THE STUDY

Niger is a landlocked country located in SSA (see Figure 1). It presently holds one of the lowest human development indexes (0.348), ranking 188th out of 188 countries, making it one of the least developed countries in the world (World Bank, 2014b). Niger's population is approximately 18.5 million with an annual population growth rate of 3.8 (World Bank, 2016b). According to the United Nations (2015), if the population growth rate continues, there will be 72 million people residing in Niger by 2050. Roughly, 48.9% of its citizens live below the poverty line (World Bank, 2014b). In rural areas 55.2 % of the people are poor in comparison to urban areas 18.6% (World Bank, 2014b). Furthermore, the vast majority of Nigeriens lack access to water, healthcare, education and employment (Blanford al., 2012; Murphy et al., 200; Alidou, 2005; Dedehouanou, 2015).



**Figure 1: Map of Niger adapted from CIA map.**

Presently in Niger, malnutrition continues to be a chronic problem (World Food Programme (WFP), 2016a) and it is the leading cause of infant mortality and morbidity (WHO, 2016b). The rate of stunted growth among children under five is over 50% percent, one of the highest in the world (WFP, 2016a). Furthermore, approximately 10% of children age 5 years and below suffer from acute malnutrition, while 44% suffer from chronic malnutrition (WFP, 2016a). The prevalence of malnutrition varies by region, however rural regions such as Diffa, Maradi and Zinder experience the highest rates of malnutrition on record (FEWS NET, 2016).

The primary cause of malnutrition in Niger is food insecurity (WHO, 2016a; WFP, 2016a). This is due to a number of factors, namely: low agriculture productivity, inconsistent rainy season, accelerated population growth and economic dependency with bordering countries such as Nigeria (USAID, 2016a). Thus, in 2012 the Nigerien government allocated 25% of its budget towards combatting food insecurity (World Bank, 2012c). An initiative titled Nigeriens Nourish Nigeriens (3N) was established to address five priority areas: 1) “to increase and diversify food, forestry and pastoral production;” 2) “improve market access by creating a favorable environment which will make it easier for producers to access inputs and sell their products”; 3) “increase focus on preventing food crises, in particular by strengthening the resilience of the most vulnerable groups;” 4) “develop preventive actions aimed at increasing and diversifying food production, promoting behavioral change, and improving access to food” 5) “dedication to political and institutional reform to improve food security”.

Presently, the 3N is in its initial phase, therefore it would be imperative for

researchers to continue to analyze the impact of food insecurity within the Nigerien population especially among women and children. To date there are limited empirical studies that examine the nutritional intake of households in Niger, and little is known regarding the factors that impact maternal and child health. Thus, there is a need for researchers to examine the dietary intake of women and children, so that effective food security policies, interventions and programs can be implemented in Niger.

## **PURPOSE**

The purpose of this study is to describe and understand food consumption patterns among women and children in Niger. The rationale is that knowledge on dietary intake of these women and children can provide empirical evidence that will guide health promotion interventions targeting this group. In addition, it can add to the current strategy (3N initiative) and help the Nigerien government develop a comprehensive, multi-sectoral and institutional tactic to reduce food insecurity in Nigerien households. Lastly, this study can assist policy makers and other stakeholders in implementing effective nutritional interventions, and health and even agricultural policies that promote healthy eating.

### ***Objectives of the dissertation***

The overall objective of this dissertation is to describe and understand food consumption patterns among women (15-49 years of age) and children (0-24 months of age) in Niger. The current study will address this objective by conducting three sub-studies, a comprehensive literature review, and two quantitative studies to obtain better understanding of dietary intake of women and children.

The study addresses the following specific objectives:

- Comprehensively examine the existing literature on maternal and child malnutrition in SSA.
- Examine the micro-contextual factors that have an impact on women's dietary intake.
- Examine the dietary intake of women residing in rural areas: Maradi and Zinder.
- Determine the built and social-environmental factors that impact the dietary intake of children in Niger.
- Provide descriptive analysis of the dietary intake of children in Niger.
- Examine maternal factors other than dietary intake that are associated with children's dietary diversity.
- Examine the differences in nutritional adequacy among children in urban and rural areas.

This dissertation will be comprised of five chapters. Chapter II, III and Chapter IV will be independent manuscripts to be submitted for publication in peer-reviewed journals.

The following is a description of each chapter:

- Chapter I offers a synopsis of the entire study with a brief introduction and rationale.
- Chapters II, provides a comprehensive systematic literature review of the food environment as it relates to dietary diversity among women and children in SSA. This chapter is the first manuscript.

- Chapter III, examines the dietary diversity of children age (0 to 24 months) in Niger. It provides the quantitative results of the factors that impact dietary diversity among children. This chapter is the second manuscript.
- Chapter IV, examines the dietary diversity of reproductive women (15-49 years of age) in Niger. It provides the quantitative results of the dietary diversity and the factors that influence dietary diversity among women. This chapter is the third manuscript.
- Chapter V, provides the discussion, conclusion and limitations of the overall study.

## **TERMINOLOGY**

Before discussing and examining malnutrition and food consumption indicators it is imperative that we provide definitions of the following terminologies: Malnutrition, The health and nutritional Status Measurement of Women, The health and nutritional status measurement of Children, Women’s Dietary Diversity Score, and Infant and Young Children Dietary Diversity Score.

Malnutrition is defined as a deficiency in the consumption of micronutrients needed for human development and growth (WFP, 2016b). An individual can become malnourished due to under nutrition (insufficient intake of micronutrients to meet daily nutritional requirements) as well as over nutrition (WFP, 2016b). Malnutrition and diseases are relatable, according to the WFP (2016b) “malnutrition is the largest single contributor to disease in the world”. However, malnutrition can at times be both the cause of diseases, and a disease caused by malnutrition (Fanzo, 2012). Malnutrition has



been described as multifactorial trait determined by “immediate, underlying and basic causes” (p.2) (UNICEF, 1998). The immediate causes operating at the individual level are a result of inadequate intake of micronutrients or disease infection that hinders the body from properly metabolizing micronutrients (USAID, 2014a). The underlying causes consist of risk factors within the household and community level (USAID, 2014a). According to USAID (2014a) “this can entail household food insecurity, inadequate care, unhealthy household environment and lack of health services”. Lastly, basic causes consist of available resources such as human, structural and financial and how they are used (USAID, 2014a).

The health and nutritional status of women in developing countries is measured by the proportion of women aged 15-49 years who have a body mass index (BMI) below 18.5 kg/m<sup>2</sup> (Micronutrient Initiative, 2016).

The health and nutritional status of children in developing is usually measured in 2 different components: 1) Anthropometric indices (WHO growth and body composition measurement) are taken and compared to that of healthy children and 2) the measurement of micronutrient deficiencies (intake analysis of iron, Vitamin A, zinc and iodine) (Micronutrient Initiative, 2016).

The Women’s Dietary Diversity score for women of reproductive age (15-49 years of age) was implemented by FAO in 2006. The Women’s Dietary Diversity instrument yields the Women’s Dietary Diversity Score (WDDS) (FAO, 2010e). WDDS is characterized as the simple count of 9 different food groups (see Table 2) consumed over a 24 hour period, and is a strong predictor of micronutrient density adequacy of

women’s diet. The consumption of 5 or more food groups represents a diverse and nutritious diet. It is important to note that in July of 2014, a new tool - the Minimum Dietary Diversity-Women (MDD-W) was created (FANTA III, 2011) and reflects some slight expansions of food categories. According to FANTA III (2015), data from the MDD-W are not yet available for examination. Therefore we utilize the most recent WDDS for the present study.

**Infant and Young Children Dietary Diversity Score (CDD)** is calculated as a simple sum of scores across the 7 categorized food groups for children 0 to 23 months of age (see table 2), ranging from 0 to 7 (WHO, 2006c). The consumption of 4 or more food groups specify a nutritious diet for both breastfed and non-breastfed children (WHO, 2006c).

**Table 2: WDDS and CDD indicators**

<b>FAO: WDDS 9 food groups</b>	<b>WHO:CDD 7 food groups</b>
All starchy staples	Grains, roots and tubers
Legumes, nuts and seeds	legumes and nuts
Meat and Fish	Dairy products
Dairy Products	Flesh Foods
Organ meat	Eggs
Eggs	Vitamin A rich fruits and Vegetables
Dark green leafy vegetables	Other fruits and vegetables
Other vitamin A rich vegetables and fruits	
Other fruits and vegetables	

## CHAPTER II

### FOOD CONSUMPTION PATTERNS AMONG WOMEN AND CHILDREN IN SUB-SAHARA AFRICA (SSA): A COMPREHENSIVE LITERATURE REVIEW

#### INTRODUCTION

Malnutrition and micronutrients deficiencies continue to be the leading risk factors for infectious diseases, unexpected deaths, and physical and mental disabilities (Muller & Krawinkel, 2005). Women and children are the most vulnerable populations (WFP, 2016a). Although malnutrition is not a direct cause, it is expected to contribute to the mortality of nearly 45% of children under age five years (WFP, 2016a). The most basic type of malnutrition is protein energy malnutrition (PEM). PEM is caused by a diet limited in energy and protein intake, resulting in a low deficiency of important macronutrients (carbohydrates, proteins and fats) (WFP, 2016a). In developing countries the top 10 leading causes of death through diseases are iron deficiency, Vitamin A, Iodine deficiency and Zinc deficiency (WFP, 2016a).

Food consumption patterns differ broadly between nations and among various societies (WFP, 2016b). An individual's average caloric intake varies significantly in least developed (2,120kcal), developing (2,640kcal) and industrialized (3,430kcal) nations per day (FAO, 2016f). Presently, in developing countries limited caloric intake significantly contributes to chronic hunger and malnutrition (FAO, 2016f). Studies have found that diets of individuals in SSA rely heavily on starchy foods with limited protein or fruits and vegetables products (Mason et al.2012; Rosen & Shapouri, 2012;

Chauvin et al., 2012). This homogenous dietary intake contributes to high rates of malnutrition (WFP, 2016a). Thus, researchers and program developers have recognized the need to thoroughly examine the dietary intake of people in SSA.

Presently, there is a paucity of studies that examine the dietary diversity in SSA, especially in regions highly impacted by malnutrition and food insecurity (FAO, 2015f). In 2006, a literature review was conducted to examine the dietary diversity measurements in developing countries. Rue (2006) found that a lack of uniformity existed in the measurement of dietary diversity among different studies. Due to this inconsistency, the comparability and generalizability of findings could not be established. Thus, recommendations were made “to improve dietary diversity measurement approaches, and to carry out validation studies to test the usefulness of diversity indicators for different purposes” (Rue, 2006, p.15).

In 2005 The Women’s Dietary Diversity Project was implemented to address the need for a basic but valid measurement of women’s diet quality, with a particular focus on micronutrient adequacy (FAO, 2010e). In 2006 the Women Dietary Diversity score (WDDS) was implemented. WDDS is measured by summing the simple count of 9 food groups consumed over the preceding 24 hours (FAO, 2010e). The consumption of 4 or more groups represent an adequate diverse dietary intake (FAO, 2010e) (see Table 2). It is essential to note in 2016 WDDS was changed to the Minimum Dietary Diversity for Women (MDD-W). However, for the sole purpose of this review we will use WDDS as the indicator to assess.

In 2007 WHO established indicators for assessing infant and young child feeding

practices (CDD) (WHO, 2010). CDD is measured by summing the simple count of 7 food groups that a child between 6-23 months of age consumes over a 24 hours period (WHO, 2006c) (see Table 2). The consumption of 4 or more groups represent an adequate diverse dietary intake (WHO, 2006c).

To the best of our knowledge, there has not been any review that examines the current state of women and children's dietary diversity in SSA after 2006. Thus, the primary goal of this systematic review is to identify and evaluate published studies on dietary diversity among women and children in SSA from 2006 to 2015.

## **METHODS**

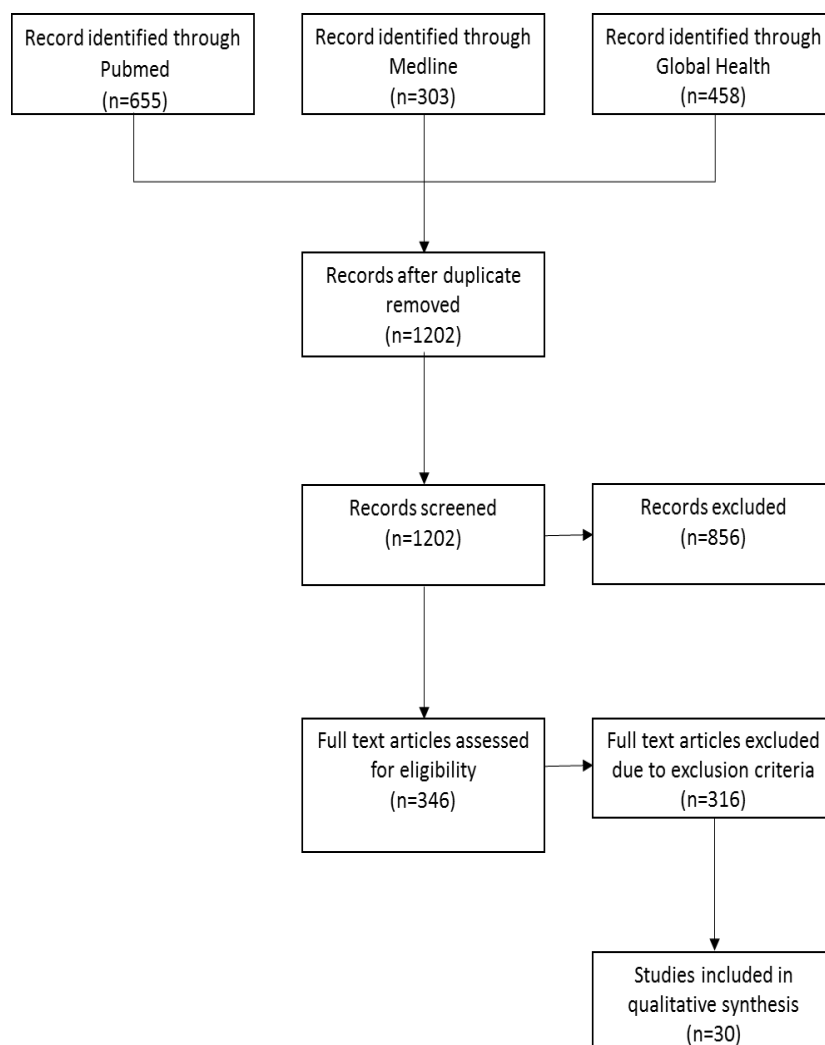
### ***Article sources***

Pubmed, MEDLINE (OVID), and Global Health were searched for articles from August 20, 2015 to January 20, 2016 to identify studies that reported on the dietary intake of women and children in SSA from 2006 to 2015. The year 2006 was selected as a starting point because it marks the implementation of the WDDS indicator by WHO. The search strategies included MesH terms and synonyms such as: “dietary diversity” OR “dietary diversity in Africa” OR ““diet surveys” AND “Maternal” OR “Children” or newborn. These terminology were similar to the previous review (Rue, 2006) and have been widely used in empirical studies that examine dietary diversity in SSA.

### ***Screening of articles***

The screening of the articles involved a three-step process. First, articles were generated based on the inclusion and exclusion criteria, resulting a total of 1,416 articles from the 3 databases. The second step involved a more rigorous screening of the articles

to fit the inclusion criteria. Articles that had unrelated titles, duplicates, commentaries, and reports that were not specific to maternal and child dietary intake, and were conducted before 2006 were removed. Lastly, we searched for additional articles from a list of references included in screening articles, this method is known as purling. This resulted in 30 additional articles identified for inclusion (see Figure 2).



**Figure 2: Systematic flow chart**

### ***Study inclusion/exclusion criteria***

The inclusion criteria were 1) empirical studies in English and or in French 2) maternal dietary and or child dietary intake, 3) includes participant's food consumption, 4) includes demographic and household characteristics 5) either quantitative or qualitative studies. Articles were excluded if they did not meet the criteria listed above, commentaries, books, organizational reports, and review articles (except systematic reviews of maternal and child dietary intake in SSA).

A list of articles were produced and independently examined and reviewed by two reviewers (NC and RM) with the three step process. Studies were excluded based on the information provided by the title and abstract. Second, full articles not included were analyzed to decide their eligibility for the review. Lastly, data extraction took place by re-examining full texts.

### ***Data extraction strategy***

The Garrard's method of literature review procedure was utilized for data abstraction and entered into a spreadsheet. The information included 1) year 2) author 3) study type 4) country 5) Language 6) sample size 7) age group 8) theoretical Framework 9) Dietary Diversity Approach 10) Method and reference group 11) Descriptive Dietary Diversity findings 12) Types of validation or association study 13) Outcome variables 14) Results 15) Score. To establish reliability, a second investigator reviewed and scored the articles independently to assess for scoring concordance between reviewers. Two differences were found in the scoring of the two investigators. The two differences in the data scoring of articles were discussed until an agreement was

finalized.

### ***Study validation***

Strengthening The Reporting of Observation Studies in Epidemiology, known as STROBE, was utilized to assess the quality and strength of the eligible studies. STROBE (2016) provides “a checklist of items that should be addressed when reporting cohort, case-control, and cross sectional studies” (p.1). The STROBE encompass 22 items that are import for writing observational studies. However, for the present study, the last item of the checklist 22 (funding) was removed from the analysis as it was not relevant, resulting in 21 items for our checklist.

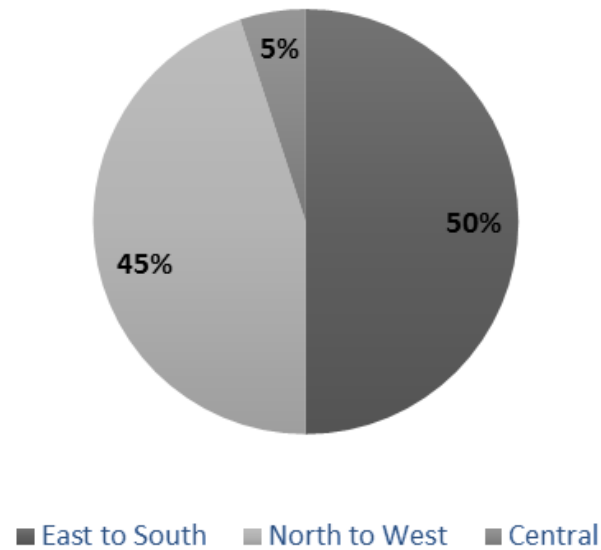
## **RESULTS**

As stated earlier and illustrated in Figure 3, 30 articles met our inclusion criteria pertaining to maternal and child dietary diversity intake. Twenty seven studies were cross sectional studies, with 2 in country reviews and 1 randomized controlled trial.

### ***Study characteristic and study quality***

Half of the studies (n=21) of the studies were conducted in the Eastern or Southern regions of Africa (see Figure 3). South Africa had the highest numbers of studies (n=9), followed by Ethiopia (n=8). The majority (n=25) of the studies were from Anglophone speaking countries. Moreover, the studies sample size ranged from 149 to 34,999 children and their mothers or caregivers. When using the STROBE tool, the highest score the studies received was a score of 20, because some failed to report on the generalizability of their findings. None of the studies reported using a theoretical framework.





**Figure 3: Regional distribution of studies in SSA**

*Summary of study characteristics*

Table 3 shows the descriptive characteristics of the outcome variables in our review. Most of the cross sectional studies (n=12) were conducted to predict the factors associated with CDD. Five studies examined women and children anthropometric measures. Four studies were conducted to examine WDDS. The rest examined food security, nutrition transition and density and food variety score.

**Table 3: Dependent variables of 30 studies**

#STUDY	CDD	WOMEN AND CHILDREN ANTHROPO METRIC MEASURES	WDDS	FOOD SECURITY	NUTRITION TRANSITION AND DENSITY	FOOD VARIETY SCORE
1	Moursi et al., 2008	Savy et al., 2008	Labadarios et al., 2011	Oldewage et al., 2006	Abrahams et al., 2011	Steyn et al., 2006
2	Lutter et al., 2011	Odunayo & Oyewole, 2006	Drime et al., 2013	Ali et al., 2013	Faber et al., 2014	Arimond et al., 2010
3	Oldewage et al., 2011	Sawadogo et al., 2006	Belachew et al., 2013	Walsh & Van Rooyen, 2015		
4	Nguyen et al., 2013	Bechir et al., 2011	Mchiza et al., 2015			
5	Aemro et al., 2013	Tessema et al., 2013				
6	Ali et al., 2013					
7	Mallard et al., 2014					
8	Faber et al., 2014					
9	M'Kaibi et al., 2015					
10	Amugsi et al., 2015					
11	Issaka et al., 2015					
12	Herrador et al., 2015					
13	Steyn et al., 2015					
14	Ogbo et al., 2015					

### ***How is dietary diversity defined and measure?***

The majority (n=27) of the studies in this review have followed FAO guidelines when defining DD, CDD, and or WDDS with the exception of 3 studies (Sawadogo et al., 2006; Moursi et al., 2008; Amugsi et el., 2015).Information of the guidelines can be found in table 1. Two studies used 8 food groups, while 1 study used 15 food groups (see Table 11). With the exception of the study conducted in 2015, it can be argued that the first two studies were conducted when the new indicators were barely implemented in research. This can possibly explain the discrepancies in their measurements.

### ***Is dietary diversity a good indicator of food consumption patterns in SSA?***

When examining dietary intake related to dietary diversity (DD) several studies (n=3) have examined trends in food consumption patterns among households in SSA (Oldewage-Theron et al., 2006; Moursi et al., (2008); Labadarios et al., (2011). One review study that examines the dietary surveys in the adult South African Population from 2000 to 2015 investigators found that average dietary diversity score were still pervasively low (4.2) (Mchiza et al.,2015). In addition, fruits and vegetables were the least food group consumed. These findings are similar to that of previous studies conducted in 2011, and 2013 (n=2) (Mchiza et al.,2015).Lastly, descriptive analysis found that more than half (n=16) of the studies, found that food group most commonly consumed in SSA is starchy staples among children and women (Moursi et al.,2008;Lutter et al.,2011;Oldewage-Theron et al.,2011;Nguyen et al.,2013;Aemro et al.,2013;Ali et al.,2013;Mallard et al.,2014; Faber et al.,2014;M’Kaibi et al.,2015; Amugsi et el.,2015;Issaka et al.,2015; Herrador et al.,2015; Labadarios et al., 2011;

Drime et al., 2013; Belachew et al., 2013; Mchiza et al., 2015).

***Is there an association between dietary diversity and type of residence?***

According to WFP (2016), approximately 63% of SSA households reside in rural areas, and are at a disadvantage of receiving adequate nutrition. In South Africa, the consumption of DD were lower among men and women residing in rural areas than in urban (Mchiza et al (2015). Furthermore, dietary diversity score was observed to be highest in urban areas (4.42) than in rural and tribal locations (3.3 and 3.17, respectively). In 2011, a similar study found that South African people residing in rural (3.64) and informal urban areas (3.46) had much lower rates of DD than those in urban areas (4.42) (Labadario et al., 2011). In Ethiopia the average dietary diversity was 7.7 in urban households in comparison to 6.4 in rural households (Hirvonen et al. 2015). It is important to note that rural residency has been associated with lower socio-economic status (FAO, 2015g). Thus, our studies demonstrate a positive association between DD and Socio-economic status (SES). Mothers from higher SES were more likely to have higher dietary diversity score than those in a lower SES (Felix et al., 2015). Similarly, children from higher SES households were more likely to have an adequate dietary diversity than those in poorer households (Amero et.al, 2015).

***What are the dietary diversity levels among women of reproductive ages?***

Our studies demonstrate that women in SSA have limited dietary diversity. In 3 South African studies the mean WDDS was 2.82 (SD=0.99) 3.17 (SD=1.21), 4.00 (SD=1.6) (Oldewage-Theron & Kruger 2011; Drimie et al., 2013; Mchiza et al., 2015). In Ethiopia the WDDS was reported to be at 3.17(SD=not reported) (Nguyen et al.,

2013) and in Ghana 5.45 (SD=2.28) (Amugsi et al., 2015). Starchy staples was the food Furthermore, a cross sectional study examining micronutrient intake of women found that micronutrient consumption was under 50% in Mali, Mozambique and Burkina Faso (Arimond et al, 2010). Additionally, limited consumption of riboflacin, niacin, folate, vitamin B-12, calcium and iron was observed (below 50%) (Arimond et al, 2010). Moreover, in Burkina Faso, cereal (98%) was the most commonly consumed food group in rural areas (Arimond et al, 2010).

We also found that similarly to households in SSA women residing in rural regions and have low education levels had lower dietary diversity scores than those in urban regions and high education levels (Aemro et al. 2013; Nguyen et al. 2013). Lastly, dietary diversity was also found to be positively associated with anthropometric measures. Underweight women had a much lower score in dietary diversity than normal weight women (Savy et al., (2008).

### ***Is CDD a good predictor of children's dietary intake?***

In SSA, children between the ages of 6 -23 months residing in Anglophone countries (Sierra Leone, Nigeria, Liberia and Ghana) had a higher dietary diversity intake than those residing in Francophone countries (Senegal, Niger, Mali, Guinea, Cote D'ivoire, Burkina Faso and Benin) (47.7% vs.22.8%, respectively) (Issaka et al.,2015). Similar to maternal dietary intake, starchy foods were the most frequently consumed food items among children. Amugsi et al. (2015) found that grains was the most frequently consumed food groups for both mothers (86%) and children (75%) in Ghana. Moreover, Steyn et al (2006) reported a high consumption of cereal (96%) among

children in South Africa. These findings were similar to that of Moursi et al. (2008) who found that starchy staples were the main food groups consumed by children age 6-23 months in Madagascar, protein foods were the least consumed. Furthermore, Faber, Laubscher and Berti (2014) found that in both rural and urban areas, the consumption of starchy staple food was consumed by more than 85% of the children. Lastly, studies have also found that CDD was positively associated with height and weight of infants and young children (Sawadogo et al. 2006; Mallard et al. 2014).

***Is there evidence of an association between WDDS and CDD?***

Studies in our review indicated similarities between WDDS and CDD (Odunayo & Oyewole, 2006; Lutter et al., 2011; Nguyen et al., 2013; Amugsi et al., 2015). In Ethiopia, a difference of one food intake among mothers was associated with a difference of 0.24 food group in children (Nguyen et al., 2013). Another study in Ghana found a difference of one food group in mother's intake was associated to a difference of 0.72 food groups in the child's food intake (Amugsi et al., 2015).

**DISCUSSION**

This cross sectional review provides insight on the use of the DD, CDD and WDDS measurements in SSA. The results from the review demonstrated that the majority (90%) of the studies were similar in their methodology and measurement of CDD, and WDDS. This uniformity in methodology and measurement may have been influenced by the increased promotion and implementation of dietary diversity indicators by FAO (2006) and WHO (2010). In addition, the main outcome variables for most of the studies was CDD and or WDDS. Although this shows progress in the examination of

the dietary intake of women and children from the 2006 review; more research needs to be conducted in order to gain better understanding of food insecurity related issues affecting women and children in SSA.

Our findings also indicate that none of the studies used theoretical frameworks. The underutilization of theoretical frameworks in these studies hinders their methodological quality. Theoretical frameworks in research provides the necessary mechanisms needed to not only formulate the research questions but the necessary procedures to conduct the study (Goodson, 2010). Glanz states “*programs to influence health behavior, including health promotion and education programs and interventions, are most likely to benefit participants and communities when the program or intervention is guided by a theory of health behavior*” (p.23). Hence, the use of theoretical frameworks not only help to produce efficient results but it also helps policymakers and program planners implement effective interventions that will benefit the overall community. Therefore, it is imperative that studies implement health behavior theories to their research in order to obtain successful outcomes.

### ***Strengths and limitations***

This comprehensive systematic literature review provides important insights in the measurement and utilization of the dietary diversity indicators for women and children in SSA. Overall, the dietary diversity indicator is a good predictor in assessing the overall dietary intake of women and children. Unlike the findings from the previous 2006 review, our review found standardization in the definition and measurement of dietary diversity indicators among studies in SSA. This standardization allows us to

compare and generalize our findings among countries in SSA. Nevertheless and similarly to Rue (2006) we believe that more methodological research is needed to untangle the complex relationship between household factors, socioeconomic factors and maternal and or child dietary diversity. Future studies should be designed to control for these socio-demographic variables, allowing researchers to better predict causal relationships and prevent them from making ecological fallacies. Moreover, the majority of our studies were conducted in Anglophone speaking countries, and in areas that were not severely impacted by malnutrition; therefore, additionally research is needed in other countries especially those mostly impacted by malnutrition.

The limitations of this review is that only countries in SSA were analyzed. Perhaps, examining the dietary diversity in other developing countries outside of SSA will provide a more in-depth knowledge on the measurement of dietary diversity indicators. Lastly, funding agencies and government entities require the evaluation and documentation of health program implementations and results. However, due to our exclusion criteria, these reports were not included in our analysis. Although these reports are not published in peer reviewed journals, it is recommended that future reviews should include them in their analysis.



## CHAPTER III

### DIETARY DIVERSITY INTAKE OF CHILDREN 0 TO 24 MONTHS OF AGE IN NIGER

#### INTRODUCTION

In Niger 45.5 % of infants and children under age five suffer from malnutrition (USAID, 2012). Malnutrition is also the leading contributor to childhood stunting (WHO, 2016). Childhood stunting affects 47% of children aged 0 to 5 years of age in Niger (WHO, 2016). Furthermore, approximately 10% of children age 5 years and below suffer from acute malnutrition, while chronic malnutrition affects 44% (WFP, 2016). The prevalence of malnutrition in this nation varies by region, with Diffa, Maradi and Zinder experiencing the highest rates of malnutrition on record (FEWS, 2016) (see Table 4). These alarming rates indicate that the vast majority of villages in Niger are impacted by malnutrition.

**Table 4: Results of the national nutrition survey (June-August 2014)**

Region	June 2009	June 2010	June 2011	June/July 2012	May/June 2013	June/July 2014
Agadez	36.3	31.6	30.6	32.0	37.2	28.2
Diffa	45.7	53	53.2	49.1	42,3	<b>42,0</b>
Dosso	41.4	47.1	49.5	43.2	37.8	31.5
Maradi	55.1	58.5	63	55.2	55.0	<b>55.9</b>
Tahoua	38.8	41.7	46.9	45	37.2	37.2
Tillabéri	40.4	37.4	36.6	37.5	38.6	38.5
Zinder	58.6	61.8	64.8	55	48.1	<b>48.3</b>
Niamey	23.2	16.6	17	19.1	17.2	24.0
Niger	46.3	46	51	46.1	42.5	45.5

Adapted from: Institut National de la Statistique (INS-Niger)

Nutritiously diverse diets are important factors for healthy living (Amugsi, Mittlemark, Odura, 2015; Nguyen et al., 2013). In 2007, WHO presented the infant and young children's (CDD) indicator, a dietary diversity measurement for children 6 to 23 months of age. CDD is calculated as a simple sum of scores across the 7 categorized food groups (see measurement section), ranging from 0 to 7 (WHO, 2016). The consumption of 4 or more food groups specify a nutritious diet for both breastfed and non-breastfed children (WHO, 2016). In SSA, the majority of children do not meet the minimum (Moursi et al., 2008; Issaka et al., 2015; Savy et al., 2008). In most poor households, starchy staples are the most commonly consumed food groups (Chauvin, Mulunga & Porto, 2012). The dietary intake of children in SSA is largely composed of grain porridges, with limited or no amounts of vegetables and meat (Amugsi, Mittlemark, & Lartey, 2014; Faber, Laubscher, & Berti, 2014).

Similarly, to other countries in SSA children in Niger have limited dietary diversity. A study found that children aged 0 to 5 consumed mostly grain porridges in the morning and mashed millet or sorghum accompanied with a vegetable sauce in the evening (Tarini, Bakari, & Delisle, 1998). Unfortunately, the vegetable based sauces tend to be limited in micronutrients (Rue, 2006). Moreover, the 2012 Demographic Health Survey for Niger yielded data demonstrating high intake of grain consumption among breastfed and non-breast fed children (47.8% breastfed vs. 75.2% non-breastfed) (USAID, 2012). In 2014, only 10% of children between the ages of 6-23 months met the minimum dietary diversity recommendations (USAID, 2016).

### ***Theoretical framework***

The Behavioral Ecological Model (BEM) and United Nations International Children's Emergency Fund's (UNICEF) Malnutrition conceptual framework provides the theoretical basis for our study. The BEM incorporates learning theory with an ecological framework (International Fund for Agricultural Development, 2016; West Africa Gateway, 2016). Under the BEM, behavior is conceptualized as a development process that is illuminated by and can be controlled through physical, and social contingencies (West Africa Gateway, 2016). These physical and social contingencies can include reinforces and other motivators of behavior (Hovell, Wahlgren, Gehraman, 2002). Based on this theoretical framework, a chain of these interacting contingencies can shape an individual's behavior. This chain ranges from broad contingencies at the societal level to more physical and social contingencies at the individual level (Hovell, Wahlgren, Gehraman, 2002). Thus, malnutrition is a multifactorial trait caused by individual, household, and environmental characteristics. It can be argued that although dietary diversity can influence good child health outcomes, as reflected by good child anthropometric growth. Different factors also contribute to this outcome. Factors such as poor nutrition, inadequate hygiene, income and medical treatment can all negatively impact one's health status (Rue, 2003; Hovell, Wahlgren & Adams, 2009). Therefore when examining causes of malnutrition it is critical to not only study individual behaviors but their environment as well.

In Niger, limited empirical studies have been conducted to examine CDD. Hence, the purpose of this study was to (1) describe CDD in Niger, (2) to determine

whether differences in CDD exist among children 0 to 24 months of age residing in Nigerien urban areas versus those in rural areas, and (3) to determine what maternal factors are associated with CDD.

## **METHODS**

### ***Data source and participants***

This cross sectional study utilized data from the 2012 Demographic Health Survey (DHS) for Niger. The DHS is a publicly available data that includes detailed information on a variety of variables relevant to population health. Data were collected specific to an array of variables “including marriage, fertility preferences, awareness and the use of family planning methods, child feeding practices, nutritional status of women and children, adult and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital mutilation, and domestic violence”(p.1). A two-stage cluster sampling method was utilized in 8 regions (Agadez, Diffa, Dosso, Maradi, Tahoua, Tillaberi, Zinder and Niamey) in order to identify eligible households (i.e., those with at least one woman aged 15 to 49 years), from which households were randomly selected. At the household level, eligible women were randomly selected to participate in the paper questionnaire. Information on the women’s characteristics and health behavior, and information on their children were obtained.

For the present study, we narrowed our sample to target women participants with children aged 0 to 24 months of age. The total sample size in the 2012 Niger DHS dataset was 11,160 (as cited in Niger Demographic Health Survey, 2012). Since the majority of mothers (94%) in the parent sample were breastfeeding, we excluded non-

breastfeeding mothers. Furthermore, dietary recommendations for breastfeeding women encompass basic food groups (grains and cereals, fruits, vegetables, dairy products and protein foods) (Faber, Laubscher & Berti, 2014) similar to CDD. In addition and all cases with missing data were removed. This resulted in a final sample size of 1419 breastfeeding mothers and their children.

### ***Measures***

#### **Child factors**

Child Age and Child Sex. Participants' mothers were asked about their child's age and sex. Age was left as a continuous variable from the original parent study (see Niger Demographic Health Survey, 2012).

Child Dietary Diversity (CDD). This factor, described earlier in this paper, is measured using the WHO-developed CDD score which in turn was calculated based on the mother's 24 hour dietary recall of their child's food consumption. Based on the WHO guidelines for infant and young children feeding, the food items listed were then grouped into 7 food groups/types: 1) Grains, roots and tubers; 2) legumes and nuts; 3) Dairy products; 4) Flesh Foods; 5) Eggs; 6) Vitamin A rich fruits and Vegetables 7) Other fruits and vegetables. The response options were "consumed" (1) and not consumed (0). CDD score was calculated by summing the scores of all the food groups, ranging from 0 to 7, making it a continuous variable.

#### **Maternal factors**

Maternal Age. Mothers were asked to report their current age. This variable was left as continuous measurement from the parent study.

Maternal Education. Mothers were asked to report their highest education level. The original response options were no education, primary, secondary and higher from the original dataset. However, due to the frequency distribution of the education level, this variable was recoded as a categorical variable no education (0) or primary and or higher (1).

Hygiene of food preparation. Mothers were asked if they washed their hands before food preparation. The response options were yes (1) or no (0). This variable was not recoded.

Women Empowerment. This factor, also known as women's decision-making score, is defined as the number of decisions a women participates in her household. For the present study, we calculated the women's decision making score by taking into account the DHS method of measuring women's empowerment. Four indicators were used: 1) deciding on one's health care; 2) deciding on how to spend one's earning; 3) deciding on making large household purchases and 4) deciding on visits to family or relatives (USAID, 2016). The women's empowerment variable was the total sum of the four indicators, score ranged from 3 to 16, making it a continuous variable.

Antenatal Attendance. Mothers were asked to report the number of antenatal visits they had during the pregnancy. This variable was left as a continuous measurement from the original dataset.

Vitamin A Intake. Mother were asked if they received Vitamin A dose in the shape of an ampoule, capsule or syrup in the last 6 months. The response options were yes (1) or no (0) from the original dataset.

Currently Amenorrhea. Mother were asked if they were currently amenorrheic. The response options were yes (1) or no (0) from the original dataset.

Anemia level. Trained staff used the HemoCue system to diagnose anemia level. An informed voluntary consent was read to the mothers, before the administration of the test. Before collecting the blood, the finger was cleaned with an alcohol swab and air-dried. Then the fingertip was stung with a retractable lancet, sterile and non-reusable. A drop of blood in a micro cuvette which was then introduced into the photometer HemoCue indicated the level of hemoglobin. This was recorded in the household questionnaire and communicated to the person tested. The original results were coded as severe (1), moderate (2), mild (3) and not anemic (4). Based on the frequency distribution of the original results, the results were recoded as no anemia (0) or moderate to severe anemia (1) in the present study.

#### Household factors.

Place of residence. Type of place of residence where the households reside where either rural (0) or Urban (1). According to USAID (2012), “urban areas are classified into large cities (capital cities and cities with over 1 million population), small cities (population over 50,000), and towns (other urban areas), and all rural areas are assumed to be countryside” (p.10).

Wealth index. According to DHS (2012) “the wealth index is a measurement of a household's cumulative living standard” (p.10). Based on the calculations the original dataset responses were poorest, poorer, middle, rich, richest. Based on the frequency distribution of the original results, this variable was recoded as poor (0), middle (1) and

rich (2).

Number of living children. Mothers were asked their total number of living children in the household. This number was left continuous, in its original form.

### ***Data analysis***

Cross sectional data analysis was conducted using SPSS version (23.0). Preparatory investigation of the frequencies for the independent and dependent variables was conducted. Descriptive analysis was conducted to demonstrate maternal and child characteristics, and child dietary intake. Frequencies of food items were conducted for rural vs. urban areas, and by regions. To compare the mean scores of CDD in relation to region an independent sample t test was conducted (23). Kruskal-Wallis test was conducted to evaluate differences between groups for CDD (23). Linear regression analysis was conducted, in order to predict child, household and maternal factors that have a significant impact on CDD (23).



## RESULTS

### *Participants' characteristics*

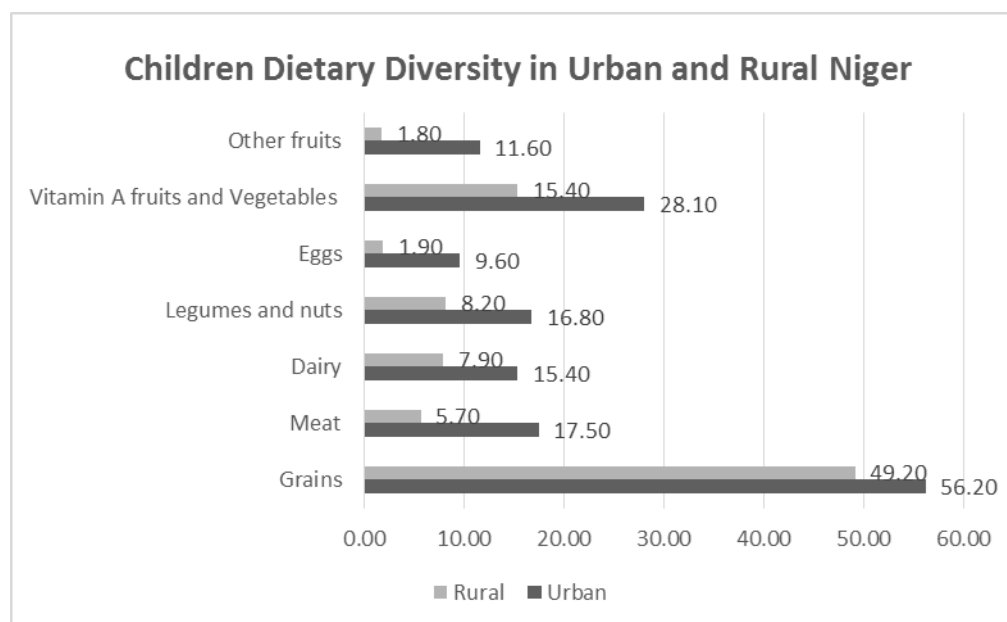
Table 5 reports the descriptive analysis of the respondents. Our results indicated that 79.4% of the participants resided in rural areas. The majority (82.2%) of the mothers had no education. The mean age of the mothers was 28 years (SD=6.6) while the children was approximately 9.3 months (SD=6.1)

**Table 5: Characteristics of respondents**

Demographic variables	N	%
<b>Region</b>		
Urban	292	20.6
Rural	1127	79.4
<b>Child Gender</b>		
Male	706	49.8
Female	713	50.2
<b>Maternal Education</b>		
No education	1167	82.2
Primary and or higher	252	17.8
<b>Wealth Index</b>		
Poor	493	34.7
Middle	291	20.5
Rich	635	44.7

### *Nigerien children dietary diversity and rural/urban patterns*

One aim of the present study was to describe the CDD in Niger. Analyses revealed grains were the most commonly consumed food group in both urban and rural areas (56.20 vs. 49.20, respectively) (see Figure 4). In addition, 28% of children in urban areas consumed vitamin A rich fruits and vegetables. Meat, dairy, legumes and nuts, eggs and other fruits were the least consumed food groups for children residing in both areas (see figure1). Our descriptive results also show that the regions with the highest consumption of legumes and nuts were Niamey (23%) and Agadez (23%). Furthermore, vitamin A rich fruits and vegetables consumption were relatively higher in Tahoua (26.9%), Niamey (25.9%), Dosso (21%) and Tillaberi (21.1%) (see Table 6).



**Figure 4: Children dietary diversity in urban and rural Niger**

**Table 6: Distribution of food groups by region**

Food Group	Regions (%)							
	Rural							Urban
Residence Type	Agadez	Diffa	Dosso	Maradi	Tahoua	Tillaberi	Zinder	Niamey
Grains	45.0	41.2	54.4	44.7	57.1	58.7	39.1	60.2
Meat	16.7	12.9	6.5	4.6	8.5	7.2	3.0	23.1
Dairy	18.3	12.9	2.0	11.3	7.5	11.2	4.5	23.1
Legumes and nuts	23.3	18.8	9.3	7.1	9.9	4.0	6.9	23.1
Eggs	10.0	4.7	0.8	0.7	4.2	4.9	3.0	8.3
Vitamin A fruits and Vegetables	21.7	18.8	21	8.9	26.9	21.1	8.9	25.9
Other fruits	3.3	3.5	1.2	2.1	6.1	1.3	1.5	19.4

CDD score by region revealed the urban areas was statistically significantly higher than in rural areas ( $t(1,417) = 6.302, p < .05; d = .66$ ). The effect size for this analysis  $d = 0.50$  indicating a medium effect. Furthermore, there was a statistically significant difference in CDD between children of different age groups,  $\chi^2 = 632.59, p < .05$  with a mean rank CDD score of 395.82 for children 0 thru 6 months, 822.00 for children aged 7 thru 11 months and 968.77 for children 12 thru 24 months. CDD score between males and females children were not significantly different ( $p > .05$ ).

### ***Predictors of child dietary diversity***

Table 7 depicts the linear regression model for the predictors of CDD. Maternal and child demographics, as well as household factors were entered in the linear regression analysis. Independent variables were considered significant indicators at  $p < .05$ . After controlling for all other variables in the model, type of residence, child's age in months, maternal age, women decision making score, vitamin A consumption, washing of hands before food preparation were significant indicators of CDD. Children residing in rural areas was negatively associated with CDD. Furthermore, our results indicate that for every unit increase in age of month, CDD score increase by .47 (95% CI: .088, .108). CDD score was also positively associated with maternal age ( $p = 0.39$ ), mothers who received a vitamin A shot in the last 6 months ( $p = 0.000$ ) and mothers that washed their hands before food preparation ( $p = 0.034$ ). In addition, a unit increase in mother's decision making indicator was associated with a .04 increase in CDD (95% CI: .002, .108).

**Table 7: Linear regression analysis of CDD in Niger**

<b>Variable</b>	<b>B</b>	<b>95% CI</b>	<b>p-value</b>
<b>Type of residence</b>			
Rural	reference		
Urban	-0.148	(-.629,-.295)	<b>0.000</b>
<b>Child Sex</b>			
Male	reference		
Female	-0.007	(-.126,.090)	0.741
<b>Child Age</b>			
	.475	(.088,.108)	<b>0.000</b>
<b>Mothers age</b>			
	0.071	(.001,.026)	<b>0.039</b>
<b>Maternal Education</b>			
No education	reference		
Primary and higher		(-.030,.285)	0.112
<b>Mothers Decision making score</b>			
	0.049	(.002,.055)	<b>0.032</b>
<b>Wash hands before food preparation</b>			
No	reference		
Yes		(.012,.311)	<b>0.034</b>
<b>Vitamin A in last 6 months</b>			
No	reference		
Yes	0.082	(.093,.322)	<b>0.000</b>
<b>Anemia level</b>			
No Anemia	reference		
Moderate to severe		(-.196,.024)	.126
<b>Currently Amenorrhic</b>			
No	reference		
Yes		(-.219,.028)	0.131
<b>Number of Antenatal visits</b>			
		(-.046,.025)	0.576
<b>Number of living children</b>			
		(-.051,.027)	0.533
<b>Wealth Index</b>			
Poor	reference		
Middle		(-.170,.130)	0.790
Rich		(-.167,.125)	0.777

Notes.  $R^2=.33$ , ( $p<.05$ ).

## **DISCUSSION**

This study was conducted to examine CDD Niger. In addition to investigate the relationship between maternal factors and CDD. This study will provide information that will aid policymakers, researchers and health promotion specialist in implementing effective nutritional health interventions to combat malnutrition.

The descriptive results and regression model indicate that children residing in rural areas are more likely to have lower scores of dietary diversity, therefore becoming more susceptible to malnutrition. These findings are similar to that of other studies in that households in rural SSA are more likely to have lower dietary diversity scores than those in urban areas (Baine et al., 2014; Codjoe, Okutu & Abu, 2016). Furthermore, grains was the most commonly consumed food group items among children making our results comparable with other studies (Moursi et al., 2008; Faber, Laubscher & Berti, 2014; Codjoe, Okutu & Abu, 2016 ). This results are not surprising since approximately 75 percent of food consumption in Niger is composed of grains (Codjoe, Okutu & Abu, 2016). Furthermore, a child's age was significantly associate with higher dietary diversity score. This finding is similar to that of previous studies (Nguyen et al., 2013; Aemro et al., 2013; Amugsi et al., 2015). This results are not unexpected, as children grow so does their ability to eat a variety of foods (WHO, 2012).

The results from our study suggest that there are positive association between maternal factors and CDD. After controlling for other variables, maternal age, and mothers who received Vitamin A intake were positively associated with CDD. To the best of our knowledge we believe this is the first study that determined an association

between mother's age and CDD in Niger. This result could also be an indicator of the high rates of child marriages in Niger. The country ranks number first in the world (UNICEF, 2015). It is possible to argue that child and adolescent mothers may have limited skills and education in providing a quality diverse diet to their children. It is important for future researchers to examine the role of child marriages and the impact it has on CDD.

According to WHO (2016) "Vitamin A is important for visual health, immune function and fetal growth and development. Vitamin A deficiency is a public health problem in many parts of the world, particularly Africa and South-East Asia". Vitamin A deficiency affects approximately 67% of children and 15% of pregnant women in Niger (Faber, Schwabe & Drimie, 2009; Aker, 2008). Due to these high rates the Nigerien government implemented a national vitamin A supplementation program. The supplementation program is moderately substantial among young children, however it remains limited among mothers (Faber, Schwabe & Drimie, 2009). Our results show the importance of the Vitamin A supplementation program for mothers, since maternal vitamin A supplementation is associated with CDD. This implies that promoting and increasing maternal vitamin A supplementation is paramount in improving the nutritional dietary diversity of children. Once again to our knowledge, we believe this is the first study to find an association between maternal age and CDD.

Moreover, in our study we found that an increase score in decision making among mothers was associated with an increase in their CDD. Although, in their study their gender empowerment variable was different (wife beating justified, yes or no)

researchers found that women who did not believe in wife beating had children that had higher dietary diversity scores than those who did believe in wife beating (Amugsi, Mittelmark, & Oduro, 2015). Furthermore, a related study in Ethiopia found that women of low status, and high disempowerment scores were associated with poor health outcomes (Aemro et al., 2013). It is important to note that studies have found that poor maternal health is associated with poor child health (Amero et al., 2013; Mallard, Houghton & Filteau, 2014). Consequently, poor maternal health can contribute to poor dietary practices of children.

Lastly, to the best of our knowledge this is the first study to examine maternal decision making score as it relates to CDD in Niger. Most studies on gender empowerment in SSA examine the role of empowerment as it relates to HIV/AIDS prevention, and family planning (Woldemicael and Tenkorang, 2010; Lailulo, Susuman, & Blignaut, 2015; Fawole and Adeoye, 2015; Minnis, Doherty, & Kline, 2015). Limited studies have been conducted that examine the impact of gender empowerment on maternal and child dietary intake. Thus, more research is needed that examines the role of women's decision making and its impact of children's dietary intake in SSA.

Lastly our analysis also showed that mothers who washed their hands before food preparation was positively associated with CDD. Malnutrition among children aged 0 to 5 years of age residing in impoverished regions is heavily influenced by numerous different factors in which hygiene is prevalent (Black et al., 2016). Limited hygiene in households can contribute to an increase in water and food borne germs and illness, contributing to outbreaks of foodborne diseases and diarrheal outbreaks (Lailulo,



Susuman, & Blignaut, 2015). Presently, diarrheal diseases is one of the leading causes of death in Niger (Fawole and Adeoye, 2015). It is important that future studies continue to examine the impact of hygiene practices and its association to dietary intake.

It is important to note the limitations of our study. Due to the cross sectional design, our analysis could not determine a causal effect between maternal factors and CDD. Furthermore, the use of a single 24hour dietary recall, can hinder the ability to collect accurate dietary information of the respondent and their children. Studies have found the use of a single 24hour dietary recall can miscalculate the food intake of the respondent (Amugsi, Mittelmark, & Oduro, 2015; Conroy, Mcgrath, Van Rooyen, 2015) Lastly, the parent study did not collect dietary intake of women or household in Niger, therefore our study was not able to determine similarities and or associations between maternal dietary intake and that of their children. Future studies should collect the dietary intake of households and women in Niger.

## **IMPLICATIONS**

The overall findings from our study suggest that CDD is a good predictor of malnutrition in Niger. Based on our results as of 2012 children in Niger have limited dietary diversity. We also found that maternal factors such as vitamin A supplementation, decision making, and washing of hands, play a significant role in CDD. Therefore, future studies should no longer limit their focus on solely examining children dietary intake but should examine cultural factors that can impact CDD. In addition more research is needed that examines the role of women's decision making and its impact of children's dietary intake in SSA.

Approximately, 2.5 million people in Niger are impacted by food insecurity (WFP, 2016). Thus, it can be argued that food insecurity is one of the primary causes of malnutrition in Niger. In 2012 the Nigerien government allocated 25% of its budget towards combatting food insecurity. With the support of international organizations (FAO, UNICEF, UNFPA, WFP and WHO), in April 2012 the Nigerien government implement a national food security initiative named 3N (Nigeriens feed Nigeriens) (FAO, 2015f). The goal of this initiative is to improve the food security by:

growing and diversifying agricultural, forestry, livestock and fisheries production, supporting urban and rural markets for small-scale producers, boosting vulnerable groups' resilience to climate change, food crises and natural disasters, improving the nutritional status of Nigeriens and maintain the momentum of reforms involving food security and sustainable agricultural development (FAO, 2015f) (p.3)

At present the program is still in its implementation phase (FAO, 2015f). It's imperative that researchers and program planners examine the effectiveness of the program. This will allow the Nigerien government and internal organizations to properly understand the strengths and weakness of the program. Lastly, nutritional studies have demonstrated that food production alone cannot make significant impact on dietary practices unless it is accompanied with nutrition education (Lassi, Kumar & Bhutta, 2016; Ahmend, Hossain & Sanin, 2012). Thus, not only should researchers examine whether the objectives of the 3N initiative have been met, but they should also investigate its overall impact on the dietary practices of their targeted communities. The investigation of malnutrition and the dietary practices of people in Niger, will aid

policymakers and program managers to implement effective dietary diversification interventions to enhance the overall nutritional quality among mothers and children in Niger.

CHAPTER IV  
EXAMINING NUTRITIONAL ADEQUACY AND DIETARY DIVERSITY AMONG  
WOMEN IN NIGER

**INTRODUCTION**

The Food and Agriculture Organization of the United Nations (FAO) defines undernourishment “as a person that is not able to acquire enough food to meet the daily minimum dietary energy requirements, over a period of one year” (FOA, 2015). Approximately 793 million people are malnourished globally, and the majority of them (98%) reside in under developed countries (FAO, 2015). Although, there has been progress in reducing the prevalence of undernourished people in Sub-Saharan Africa (SSA), the region continues to hold the highest prevalence rate of hunger in the world (World Food Programme [WFP], 2015). Roughly one in four individuals in SSA are undernourished (WFP, 2015).

In SSA countries such as Niger, malnutrition continues to be a major threat to public health; whereby the country’s prevalence rate of global acute malnutrition (GAM) increased from 13.3% in 2013 to 14.8% in 2014 (Institut national de la Statistique (INS) & Systemes d'Alerte Precoce (SAP), 2015). According to WFP (2015), Niger’s prevalence rate of GAM is far above the 10.0% warning threshold and is dangerously close to the emergency threshold of 15.0% set by the WFP. The highest prevalence of malnutrition is seen in the Maradi region with 15.7% of its population suffering from GAM and the lowest prevalence rate (12.8%) in Niamey the capital city (INS and SAP,

2015). Furthermore, approximately 2.5% of the rural population in Niger is in severe food insecurity, roughly 13.2% of individuals are moderately food insecure and or 33.3% are classified as “at risk”, for food insecurity (INS & SAP, 2015).

Nutritional intake in malnourished populations such as in Niger is frequently deficient in macronutrients (protein, carbohydrates and fat, leading to protein–energy malnutrition), micronutrients (electrolytes, minerals and vitamins, leading to specific micronutrient deficiencies) or both (Famine Early Warning Systems Network ,2015). Furthermore, amid great harvest years in Niger, the nourishment and sustenance of the poor and exceptionally poor households remains extremely fragile due to limited production capacity aggravated by high indebtedness, low purchasing power and high dependency – i.e., reliance on men to meet basic needs (WFP, 2015). Moreover, studies have found that malnutrition poses the greatest threat to Niger’s most vulnerable demographic: women and children (International Federation of Red Cross and Red Crescent Societies, 2011; Delisle, 2008; Kimani-Murage, Muthuri, Oti,Mutua,van de Vijver & Kyobutungi,2015; Ahmend, Hossain, & Sanin, 2012).

Malnutrition represents an assortment of threats to women’s health (Bhutta et al., 2013). One of the key determinants of maternal mortality, and healthy pregnancies outcomes is the nutritional status of women aged 15-49 years (INS; Minister des Finances; ICF International, 2015). Malnutrition debilitates their capacity to survive childbirth, and renders them more vulnerable to infectious diseases (Ahmend et al., 2012). In addition, HIV-positive mothers who are malnourished may be more inclined to transmit the infection to their newborn child and to experience an accelerated transition

to AIDS (Magadi, 2011). Malnutrition also undermines women's productivity, their ability to generate income, and their capacity to tend to their families (Ahmend et al., 2012).

Furthermore, maternal malnutrition not only has a significant impact on infant morbidity and mortality outcomes, but it is also the leading contributor to childhood stunting (World Health Organization [WHO], 2015), and is the primary cause of mental retardation and brain damage in some children (Levinson & Bassett, 2007). Presently, in Niger, a significant proportion of women (16%) have body mass index (BMI) below the critical threshold of 18.5 kg/m<sup>2</sup><sup>1</sup>. Approximately, 17% of women residing in rural areas are malnourished compared to 11% in urban areas (INS, Ministere des Finances, ICF International, 2012).

In order to assess the nutritional intake of women in developing countries, the FAO developed an assessment tool in 2010 - The Women's Dietary Diversity instrument, which yields the Women's Dietary Diversity Score (WDDS) (FAO, 2010). WDDS is characterized as the simple counts of 9 different food groups (see Table 8) consumed over a 24 hour period, and is a strong predictor of micronutrient density adequacy of women's diet. In July 2014, a new tool - the Minimum Dietary Diversity-Women (MDD-W) was created (Food and Nutrition Technical Assistance (FANTA III), 2015) and reflects some slight expansion of food categories. According to FANTA III (2015), data from the MDD-W are not yet available for examination. Therefore we

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<sup>1</sup> An individual with a BMI index of less than 18.5 kg/m<sup>2</sup> is considered to suffer from chronic energy deficiency. (DHS)

utilize the most recent WDDS for the present study.

This study has two purposes. First, to identify and describe WDDS in two regions in Niger: Zinder and Maradi. These two southern regions have shown persistently high rates of acute malnutrition over time (INS & SAP, 2015). Secondly, to determine household factors that have an impact on WDDS.

**Table 8: Food groups for women’s dietary diversity score tool**

All starchy staples	Eggs
Legumes, nuts and seeds	Dark green leafy vegetables
Meat and Fish	Other vitamin A rich vegetables and fruits
Dairy Products	Other fruits and vegetables
Organ meat	

## **METHODS**

### ***Data source and subjects***

This cross sectional study utilized baseline data from a larger study conducted by the United States Agency for International Development (USAID) Office of Food for Peace (FFP). The 2013 Baseline Study of Title II of USAID investigated household food access; sanitation and hygiene; agriculture; household expenditures and assets; and nutrition and health among women and children (USAID, 2015). Data collection took place in 12 communities within Zinder<sup>2</sup> and Marandi<sup>3</sup> regions from February 26 to March 30th 2013. The sample size for the parent study (i.e., 2013 Baseline Study of Title

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<sup>2</sup> Kantche-Bandawa, Kantche-Douache, Mirriah-Diney Haoussa, Mirriah-Fortoro Bougage

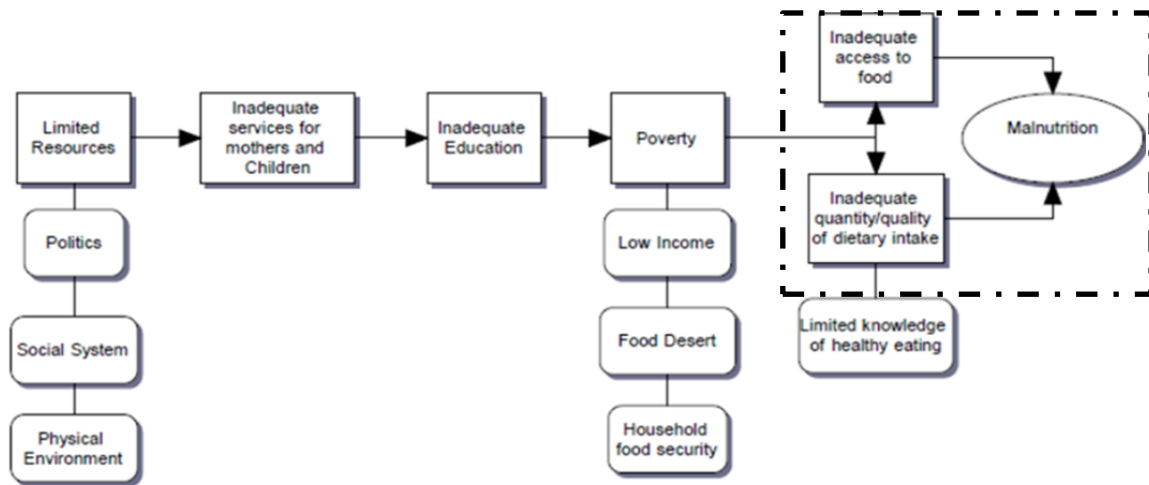
<sup>3</sup> Guidan Roudji-Guidan Sori, Guidan Roudji-Tounkourma, Aguié-Naki Karfi, Aguié-Chakpe, Mayahi-Jan Toudou, Mayahi-Zongo Yardi, Dakoro-Dan Goubli, Dakoro-Magajin Kori

II) was 7,337 households, with 6,050 women between the ages of 15-49 years interviewed. For the present study, we set our inclusionary criteria to be cases with no missing data on the variables of interest. The resulting total sample size of women between the ages of 15- 49 years for the present analysis was 3,360.

### ***Theoretical framework***

Guided by the Behavioral Ecological Model (BEM) and UNICEF's conceptual framework for malnutrition, a conceptual model was implemented to illustrate the influencing factors that lead to malnutrition. The BEM perceives the intertwined relationship that exists between the individual and the environment (Hovell, Walgren & Adams, 2009; Dresler-Hawke & Whitehead, 2009). It predicts that the collaboration of an individual's social and physical environment is the best indicator of their behaviors. The UNICEF's conceptual framework explains the multiple and interrelated determinates of malnutrition, and the multifaceted and multisectorial approaches needed to solve it (Goudet, Faiz, Bogin & Griffiths, 2011). Both of these frameworks take into account the impact of behavioral relationships, exchange mechanisms, and multi-level dynamics that influence dietary intake at the individual, household and community level. For the purpose of the present study, we examine a portion of the conceptual (see Figure 5; delineated by dashed lines)





**Figure 5: Schematic of factors and assumptions that lead to malnutrition**

### *Measures*

#### Women Dietary Diversity

The key outcome variable was WDDS. Women were asked a list of food items they ate during the previous day or night. These food items were then classified into 9 food groups as follows: 1) all starchy staples; 2) dark green leafy vegetables; 3) vitamin A rich fruits and vegetables; 4) other fruits and vegetables; 5) organ meat; 6) meat and fish; 7) eggs; 8) beans or seeds; and 9) dairy products. The response options were “consumed” (1) and not consumed (0). The WDDS was derived as a simple sum of scores across the 9 categorized food groups, ranging from 0 to 9. The consumption of 4 or more food groups indicated that their diets offer some diversity in both macro and micro nutrients.

#### Covariates

We examined household factors that could influence WDDS. These factors were region: Zinder (1), or Maradi (2); ownership status of house: owned (1), co-Owned (2),

being purchased (3), employer provides (4), free Authorized (5), free not authorized (6), rented (7); age; total number of household members; total number of women 15-49 years of age in household, total number of eligible farmers in household; and total number of children under 5 years of age. Household hunger scale (HHS): (0 to 1) little to no hunger or (2 to 6) moderate to severe hunger was used as a critical food insecurity scale. The overall Household Dietary Diversity Score (HDDS) was based on the quantity of different food groups consumed by the head of the household or any other household members in the previous 24 hours. The HDDS score ranged from 0 to 12 with lower numbers showing less dietary assorted qualities.

### ***Data analysis***

Data analysis was conducted using IBM SPSS version 2015 (SPSS, Inc., 2015). Analysis included the inspection of the frequencies for the independent and dependent variables. Descriptive analysis was conducted to display participant's characteristics, regional location, and food group consumption by women and their region. Due to the nonlinearity of the data non parametric statistical tests including Mann Whitney U tests were used to evaluate the differences between regions. Multivariable linear regression was used to examine the factors associated with WDDS. All statistical tests were two sided and assumed significance at ( $p < .05$ ).

## **RESULTS**

### ***Description of the study sample***

The study sample size was 3,360 women between the ages of 15 to 49 years ( $M=29.6$ ,  $SD=8.1$ ). Over half (56.7%) of the participants were residing in the Maradi

region. The majority of the participants (94.9%) were residing in households with both male and female adults. Overall, 31.2 % of participants' households suffered from moderate to severe hunger (see Table 9).

**Table 9: Characteristics of women and their households**

Characteristics	n	Percent
Region		
Zinder	1456	43.3
Maradi	1904	56.7
Ownership status of house		
Owner	2616	77.9
Co-owner	606	18
Free authorized	104	3.1
Other	34	1
Household Hunger Scale		
Little to no hunger	2313	68.8
Moderate to severe hunger	1047	31.2
	<b>Mean</b>	<b>SD</b>
Age	29.63	8
Household size	7.75	3.55
Number of women 15-49 years old in the household	1.42	0.689
Number of eligible farmers in the household	1.27	0.747
Number of children under 5 in the household	1.89	1.11
Average HDDS score	3.35	1.89

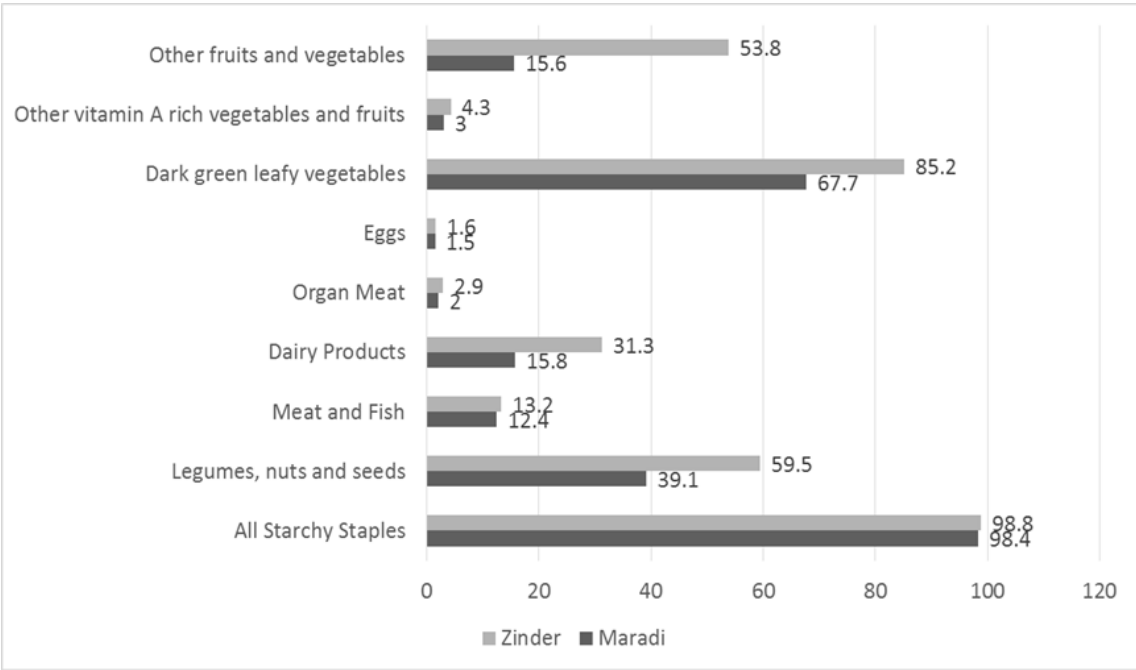
### ***Dietary diversity in Zinder and Maradi***

Our first purpose was to describe dietary diversity (WDDS) of women in the two regions (Zinder and Maradi). Mean WDDS was 3.5 (SD = 1.3) in Zinder, and was higher than the WDDS score of 2.5 (SD = 1.28) in Maradi ( $p < .05$ ). In addition, our study results

demonstrated close similarities between the diets of women living in Zinder and Maradi.

The most consumed food items in both Zinder and Maradi were starchy staple foods (98.8% and 98.4%, respectively); the vast majority of participants (98.3%) reported a high consumption of grains within the starchy staple food group (see figure 2).

Furthermore, there was a significant difference in the consumption of dark green leafy vegetables, other fruits or vegetables, and beans or seeds between Zinder and Maradi ( $p < .05$ ). Flesh foods and eggs were the least consumed food items among women in both regions (see Figure 6).



**Figure 6: Different food items consumption by women in Zinder and Maradi**

### ***Household factors and WDDS***

Our second purpose was to identify important household factors that affect WDDS.

Table 10 demonstrates the results of multivariable linear regression for predictors of WDDS. Independent variables were considered significant predictors at  $p < .05$ . After controlling for all other factors that affect WDDS in the estimation, our results indicate that region, number of eligible farmers in the household, HDDS and HHS have significant effect on WDDS. Specifically, our results indicate number of farmers in the household has a positive and significant effect on WDDS. For every household reporting a presence of a farmer, WDDS increased by .1 units. HDDS also had a positive significant effect on WDDS, a unit increase in HDDS was associated with a .396 increase in WDDS.

**Table 10: Linear regression analysis of WDDS in Niger**

Variable	<i>B</i>	95% CI	p-value
Region, 0 Maradi, 1=Zinder	-0.510	(-.592,-.427)	0.000
Age	-0.005	(-.010,.000)	.061
Ownership Status of House, 1=Owner, 5=Other	-0.035	(-.076,-.006)	0.096
Household Hunger Scale, 0 to 1=little to no hunger, 2 to 6=moderate to severe hunger	-0.204	(-.286,-.123)	0.000
Household size	0.012	(-.005,.028)	0.162
Number of women 15-49 years old in the household	0.003	(-.069,.076)	0.930
Number of children under 5 in the household	-0.032	(-.073,.009)	0.121
Number of eligible farmers in the household	0.101	(.049,.152)	0.000
Average HDDS	0.396	(.376,.416)	0.000

Notes.  $R^2=.40$ , ( $p<.05$ ).

## DISCUSSION

This study provides information on the dietary intake of women in Niger, and the factors that have a significant impact on WDDS. Furthermore, our study will inform policy makers and program planners on how to implement effective policies and programs tailored to improving the quality of nutrition intake in Nigerien women and other developing countries.

Descriptive results of this study indicated that women in Niger have a limited WDDS. The majority of the women consumed foods made from cereal grains. These findings are similar with other comparable studies (Nguyen et al., 2013; Araujo, Bonjean

& Brunelin, 2011; Hatley, Hallund, Diarra, & Oshaug, 2003). In addition, these results are not surprising as Pearl millet is the most important grain in Niger (Egg & Wade, 2006). Niger produces 21% of West African millet production, making it the second highest producing country in the continent (Araujo et al., 2011). Pearl millet is primarily consumed as either thick or thin porridges or steamed into grainy food items (Ndjeunga & Nelson, 2005). Similarly, to previous studies flesh foods and eggs were the least consumed food groups (Nguyen et al., 2013).

Results of this study indicated that women residing in Maradi have a less diverse diet than those residing in Zinder. Over the years Maradi region has shown persistently high rates of acute malnutrition due to periodic droughts and pest attacks (Zakari, Ying & Song, 2014). Maradi experienced food shortages in 1973-75, 1984, 1998, 1989, 1994, 1996, 2000 and 2005 (Adewusi, Falade, Oyedapo, Rinaudo, & Harwood, 2006). As stated previously, this region continues to hold the highest rate of GAM (15.7%) in the country and one of the lowest rate (17.5%) of food diversity intake of children 6 to 23 months of age (Ahmend et al., 2013). The lack of dietary diversity among the most vulnerable (women and young children) will have adverse health consequences population-wide over time.

Moreover, we found that for every participant reporting a farmer in their household, their WDDS increased. Similarly, in their study Sibhatu, Krishna, and Qaim (2015), found that diversification of food items in farming is positively correlated with dietary diversity intake. Although their outcome variables were different in their study, USAID (2015) found that each additional farmer in the household decreased the odds of

household hunger. To the best of our knowledge we believe this is the first study to examine the relationship of farming and the presence of a farmer in the household to WDDS in Niger.

Lastly, in our examination of household factors, we confirmed two relationships we expected per our conceptual model. WDDS were lower for women in households experiencing hunger (Household Hunger Scale), and were higher in households with greater Household Dietary Diversity (HDDS). Similarly, Hatley et al. (2000) found that HHS was negatively associated with the consumption of food variety among households in Mali. In addition, Oldewage and Kruger (2011) and Vuong, Gallegos, and Ramsey (2015) found that limited food access in poor households resulted in inadequate nutrient intakes.

Despite the important contributions of the current study to the extant literature, some limitations are important to note. Participants were asked to recall their 24 hour dietary intake, this method may have contribute to recall bias. Due to recall bias the information provided may not be representative of the participants' long term dietary habits. Thus, as a recommendation by Holmes, Dick and Nelson (2008) future studies should conduct four repeated 24 hour recalls in order to capture a more accurate dietary assessment of participants' dietary intake. Furthermore, the data from this study was derived from a baseline study that was conducted prior to the start of a program implementation, therefore data collection was conducted within a very limited time frame. This could have impacted the internal validity of the study.

As described previously, a newer indicator of dietary diversity (Minimum



Dietary Diversity-Women [MDD-W]) was made available (FANTA III, 2015). The newer version expands upon two categories of the WDDS tool in two ways: 1) expanding the single legumes, nuts and seeds category into two categories (beans & peas; nuts and seeds), and 2) expanding organ meat category to include any flesh foods. It also specifies dark leafy vegetables to be rich in vitamin A. Given the similarity of consumption patterns between the two regions for starchy staples, meats and fish (flesh foods), the new tool is not likely to have found much difference. However, utilization of the newer measure may have refined our understanding of differences within other categories which underwent changes. Nevertheless, data using the MDD-W is not available yet. We recommend future research be conducted with our same study purpose, but using the new data when made available.

## **IMPLICATIONS**

Malnutrition remains significant public health problem in most part of the developing world (WFP, 2016a). Although the causes of malnutrition are directly related to inadequate dietary intake, indirectly, it has a negative health impact on women and children, especially in countries such as Niger (WFP, 2016a). Our findings from this study has 2 major implications. First, it is important to continue research that will examine malnutrition in Maradi. During the 2005 food crisis Maradi was at the forefront of international news. This region turned into the scene of stunning pictures of malnutrition and high child mortality in Doctors without Borders (DWB) health centers and its nutrition intervention programs. Furthermore, according to DWB (2012), in 2013 children residing in Maradi have continued to endure exceptionally high rates of

malnutrition. Presently, children under five residing in Maradi have the highest rate of acute malnutrition and it is the only region in Niger that is influenced by pockets of malnutrition (DWB, 2012).

Although, Maradi is inundated with high rates of malnutrition it is the highest crop-producing region in Niger. Agriculture is the primary activity for 85% of households residing in rural Niger especially in Maradi (Mamadou & Salaou, 2013). However, because the region is heavily dependent upon rain to maintain its agriculture, Maradi is also highly vulnerable to climate changes such as severe droughts. Mamadou et al. (2013) argues that environmental change is having a serious impact on crop production, especially beans, a critical source for protein. Unfortunately, in Niger, millet production and prices are severely impacted by periodic droughts. Grain prices tend to become elevated immediately after a failed harvest due to poor climate conditions. This can have a negative impact on food security such as the case of the 2005 food crisis in Niger.

Based on the BEM in order for individuals to improve their quality of life, it is crucial for their environments to be accommodating. Thus, it is important that government and nongovernment agencies continue to examine the causes of malnutrition related to food security in Maradi. Alternative solutions to provide food sources that does not include a sole reliance on rain water must be examined. Secondly, from a programmatic perspective our study results support the focus on family farming programs. Agricultural and health promotion programs should continue to encourage family farming.

In order to tackle the malnutrition crisis in Niger, in April 2012 the Nigerien government implemented the 3N initiative (Nigeriens feed Nigeriens) with the support of UN agencies (FAO, UNICEF, UNFPA, WFP and WHO) (West Africa Gateway, 2013). This multi-sectorial policy aims to enhance the structural causes of malnutrition and food insecurity by advancing rigorous farming models and sustainable management of natural resources. Presently, the 3N's implementation phase (2012-2015) is ongoing. Thus, it would be crucial for researchers to examine the progress of the initiative and its impact on food security. More research is needed to better understand how agriculture and food systems can be made more nutrition-sensitive in particular situations.

To further enhance and encourage Niger's nutritional programs, in July 2015, the United Nations International Fund for Agricultural Development (IFAD) and the government of Niger consented to support and finance Family Farming Development program (FFDP) located in Maradi, Zinder and Tahoua. This financing involves a US\$24.25 million advance, a \$24.25 million stipend and an extra \$13 million gift from IFAD's Adaptation for Smallholder Agriculture Program (ASAP):

The funding is intended to assist smallholder family farmers involved in agro pastoral activities to proliferate and expand their agricultural production by improving production techniques and small scale irrigation systems. Furthermore, the program will finance rural infrastructures such as roads, collection centers, and markets logistics to encourage better and more proficient linkages between production areas and consumption centres (p.10).

The implementation of this program is extremely valuable to family farming, not

only for food security, but it can provide revenue for the vast majority of people in need. Ultimately, it is crucial that such programs take into account the importance of nutrition in women and children. According to WFP (2016a), ‘if women farmers had the same access to resources as men, the number of hungry people in the world could be reduced by up to 150 million’. Without question, Niger represents the ideal location where public health researchers and officials can begin to address malnutrition on a local and national level in hope that results from such interventions can eventually allow Niger to serve as a model for the rest of the world as to what can be accomplished when preventive measures are implemented.

## CHAPTER V

### CONCLUSION

The overall goal of this dissertation was to contribute to the current body of knowledge in regards to maternal and child dietary intake in SSA. Research on dietary intake of women and children will help guide policy makers, researchers and program developers implement health programs that addresses malnutrition among women and children in SSA.

Additionally, it can assist policy makers, government entities, and other stakeholders in designing effective health policies and nutrition interventions to combat malnutrition. The research consists of three distinct studies that addresses 3 important aspects of the malnutrition (1) food consumption patterns among women and children in SSA, (2) the dietary diversity among children 0 to 24 months of age in Niger, and lastly the (3) nutritional adequacy and dietary diversity among women of reproductive age in Niger.

To fully examine the dietary intake of women and children in SSA, a comprehensive literature review was conducted to assess the literature and report on the availability of food consumption patterns in SSA after the Niger 2005 food crisis and the implementation of WDDS and CDD. The review sought to address three issues: 1) the food consumption patterns of maternal and child dietary intake in SSA, 2) the predictive factors of dietary diversity among women and children in SSA and 3) the major findings of the existing studies. Data extraction for the systematic literature review was

conducted by using the Garrard's method. Based on our literature review we found that women and children were still vulnerable to malnutrition. Both women and children had low dietary diversity scores. Their diets were mostly based on starchy staples with limited intake of protein or fruits and vegetables (see Chapter 2). Moreover, we found that women and children residing in rural regions and in low SES households were more prone to having low dietary diversity scores. These results are not surprising, since the rate of poverty in rural regions is approximately 75%. Thus, numerous households in rural SSA are susceptible to food insecurity and malnutrition.

Furthermore, we found that the majority of the studies from different countries utilized the same measurement for WDDS and CDD to conduct their studies. Thus, it can be argued that the promotion of FAO and WHO measurement tools of dietary diversity for women and children has been successful in obtaining a common indicator approach for SSA. This allows researchers to make the results more generalizable and comparable to other countries in SSA.

Moreover, based on our findings from our literature review we can conclude that there is paucity in the literature regarding the dietary diversity among women and children. These results were not unexpected, since the present nutrition research agenda has mostly been driven by researchers in developed and high income nations, while the ability for researchers in SSA to obtain competitive global funding has been limited (Lachet et al., 2014). This shortage of international funding creates a genuine lack of research among African social and behavioral scientists that focus on public health research, specifically in nutrition (Wight, 2008).

Over the years there has been various endeavors by WHO and UN agencies to increase research capacity in underdeveloped countries. However, there is still evidence showing a serious deficiency of public health research in SSA (Wright, 2008). In 2008, only 1.1% of scientific publications came from Africa (UNESCO, 2010). A study examining social scientists in East Africa, found that a large portion of research conducted by researchers is through consultancy work. The researchers in this study expressed limited departmental and faculty support to conduct research. Furthermore, the individualistic nature of the departments hinders senior faculty from co-authoring or collaborating with junior faculty (Wright, 2008). Thus, it can be argued that the lack of funding and collaboration among faculty negatively impacts public health research. Consequently, there is still a need to comprehensively examine the nutritional environment of households, in particular women and children in order to address malnutrition.

Lastly, our findings revealed gaps in the literature on regional studies, we found that public health research is predominately conducted in Anglophone countries in SSA (see Table 11). Meneghini et al (2007) argues that the English language has turned into the most widely used language, especially in the scientific world. This is because the world is presently dominated “economically, scientifically, and culturally by Anglo-American countries” (Meneghini et al (2007), p.1). Due to these circumstances, researchers who seek to obtain global recognition and access to pertinent publications, must therefore master the English language. Although this would facilitate the global communication of scientists, it can create problems for non-English speaking countries

(Meneghini et al., 2007; Benie-Bi et al., 2013; Hwang, 2013). English writing can be difficult for non-English speaking researchers, and the publication in English when the original writing is in another language can be costly (Sunol, 2008; Hwang, 2013). Moreover, regardless of the fact the researcher from non-English countries can read English publications, in order for them to gain recognition and support they must also be able to interpret the information obtain into a national agenda (Meneghini et al., 2007).

Presently in SSA there are 31 French speaking countries, and 6 Portuguese speaking countries. In Guinea Bissau the official languages are Spanish, French and Portuguese (WHO, 2016). Thus, researchers from these countries have to overcome significant barriers in order to publish their work in peer reviewed scholarly journals. It can be assumed that these inconvenient barriers can often times discourage researchers, making them less motivated to conduct and publish research. This creates a major gap in public health research, because valuable information may be lost from these countries (Wright, 2008). Consequently, there is a need for public health research in non-English speaking countries in Africa.

The findings of the systematic literature review on the CDD and the lack of empirical studies of children's dietary intake in francophone Africa guided the purposes for the second manuscript (chapter 3). This study's main objectives were to 1) describe CDD in Niger, 2) determine whether differences in CDD exist among children residing in Nigerien urban areas versus those in rural areas, and 3) to determine the maternal factors that are associated with CDD. The total sample size was 1, 419 children between the ages of 0 to 24 months. The overall score of CDD was low, however children



residing in rural areas had much lower scores than their counterparts in urban areas. These findings were not only similar to the findings from our literature review (chapter 2) but were also similar to recent studies (Amugsi et al., 2015; Codjoe et al., 2016).

We also found that maternal factors such as (washing of hands before food preparation, receiving vitamin A intake, and decision making score) were all significant predictors of CDD. Our results of hygiene and decision making score were similar to that of previous studies conducted in other developing countries (Pengpid et al., 2012; Quinlan et al., 2013; Amugsi et al., 2015). To the best of our knowledge, we believe this to be one of the first studies that examine vitamin A intake among mothers and CDD in Niger. Therefore, it can be argued that women who receive vitamin A intake are more likely to be informed about the importance of dietary diversity, thus in return feed their children a more diverse diet. Lastly, the overall findings from our study indicated that CDD is a good predictor of malnutrition among children in Niger. These results are consistent with the studies in our review (chapter 2) and a review conducted by UNICEF (2011).

The overall findings of the limited CDD in Niger from the second study, and lack of nutrition interventions for women of reproductive age from our literature review, guided the development of the purposes for the third manuscript. In Chapter 4 (Manuscript 3), the investigator sought out to examine the dietary composition of women of reproductive age (15-49 years of age) in Niger. This study had two purposes 1) to identify and describe WDDS in two regions (Zinder and Maradi) that have the highest malnutrition rates in Niger, and 2) to determine the household factors that are

associated with WDDS. Our findings indicate that women had limited dietary diversity, especially those residing in rural Maradi, the region that is highly affected by food scarcity (WHO, 2010; Zakari, Ying & Song 2014). Similarly, to children dietary intake in the previous study, we found in this study that starchy staples was the food group most highly consumed. According to the World Bank (2009), grain consumption in Niger embodies 50 % of the total household expenditures. Flesh foods, fruits and vegetables were the least consumed food groups. The findings of this study were also consistent with the findings of our systematic literature review (manuscript 2). Lastly, the factors associated with WDDS were region, household hunger scale, total number of eligible farmers and average household dietary diversity score and these were all strong predictors of WDDS. These factors with the exception of total number of eligible farmers, have all been reported as predictor of DD in households, CDD and WDDS from our systematic literature review. Overall, the findings of this study reinforces the importance of conducting more studies that examine the nutritional intake of women in Niger. This will provide an in-depth investigation on the malnutrition crisis affect the Nigerien population.

In conclusion, the analyses of the studies presented in this dissertation, provide important additional relevance on the nature of dietary diversity among women and children in Niger. Niger is presently one of the countries with high levels of malnutrition globally. However, limited empirical studies have been conducted that examine the predictive factors of women and children's dietary intake. To our knowledge, these are the first analyses that 1) investigated WDDS in Niger and 2) examined maternal

predictor factors of CDD.

## **LIMITATIONS**

Data derived for (Chapter 3 and Chapter 4) were collected from surveillance studies conducted by USAID and DHS. Thus, due to the cross-sectional design of the studies, causal inferences between the predicting factors (see Chapter 3, Chapter 4) and the outcome variables of interests (WDDS and CDD) cannot be established. In addition, the two datasets provide information on either child dietary intake (DHS) or maternal dietary intake (USAID). Both datasets did not provide combined information of child and maternal dietary intake, therefore our studies could not make associations between maternal and child dietary diversity.

Lastly, the dietary intake of children and women were called in a 24-hour dietary period. Although, these are the recommendations from FAO and WHO, a sole 24-hour period can hinder researchers from obtain an accurate description on an individual's dietary intake and diversity. It is recommended that prospective studies conduct 4 repeated 24 hour dietary recall that will provide the investigators with a more precise and accurate dietary assessment of the participants (Dick & Nelson, 2008).

## **IMPLICATION FOR HEALTH EDUCATION AND RESEARCH**

Limited research in SSA indicates a need to elevate the number of public health researcher and researchers in the continent. To achieve this goal it is imperative that African governments begin to support and encourage their public health institutions and schools. According to Williams et al (2010) “research training for public health professionals is key to the future of public health policy in Africa” (p.3). The training to

effectively design, implement and evaluate health policies and programs is extremely limited among the few public health professionals in Africa (Willams et al., 2010).

In addition, numerous graduate public health programs continue to be traditional, with limited perspectives of public health research. This is partly due to the fact that most of the public health graduate programs stem from community health or community medicine departments (IJsselmuiden et al., 2007). In Anglophone countries these departments are equivalent to medical schools. This limits public health research and education to only medical practitioners (IJsselmuiden et al., 2007). Studies argue that in order for a country's health system to be efficient an association between public health education and public health research must be established (IJsselmuiden et al., 2007; Petrakova & Sadana 2007; Haines & Huttly, 2007). Therefore, the promotion of public health programs should not only be in medical schools but should be integrated as a standalone degree within institutions. These programs should combine research and education, so that emerging public health leaders can implement effective solutions that will enhance the health care systems of their respective countries.

Lastly, according to FAO (2015f) SSA success in combatting malnutrition and achieving food security goals relies heavily upon national and regional drivers to be able to implement:

effectiveness of political leadership and governance, the quality of the policies and strategies in the food and agricultural sector, the soundness of the macro-economic environment, the inclusiveness of economic growth, and the degree of economic integration or interconnectedness, among others (page18).

In 2012 Niger implemented “Nigériens feeding Nigériens” (3N), a multi-sectorial coordination structure to enhance food security. This initiative is chaired by the Minister of Health and co-chaired by UNICEF. Niger, under the aegis of the 3N Initiative, and other sectors, aims to accelerate global nutrition actions and improve efficiency, particularly in terms of health, agriculture, livestock, education, water, and environmental protection. The country is presently engaged in the development of a national nutrition security policy on the basis of concrete elements together with a multi-sectoral action plan. Presently, the 3N initiative is still in the implementation stage. Therefore, it is critical for researchers to examine the impact of this initiative on the dietary intake of women and children. The evaluation of this initiative and its program will help policy makers and researchers, and health program developers design health interventions that meet the needs of the vulnerable populations. Lastly, researchers should aim to conduct interventions that will help to predict causal factors of dietary diversity in Niger, and SSA as a whole.

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APPENDIX

**Table 11: Matrix of literature review**

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2006	Oldewage-Theron, W. H., Dicks, E. G., & Napier, C. E.	Cross sectional	South Africa	English	357 caregivers and 149 children	children age=9-13 years old	no theoretical framework	A validated quantified food frequency questionnaire (QFFQ)	24hour recall	“The female caregivers were stiff maize meal porridge, soft maize meal porridge, brewed rooibos tea, brewed tea, brewed coffee, sorghum porridge, white bread, crumbly maize porridge carbonated cold drink (52 ml) and mageu, a commercial sorghum drink (51 g). The only protein sources included in the top 20 list were soy beans (11th) and chicken and vegetable stew (13th) with mean daily intakes of 51 g and 45 g, respectively. A minority of respondents consumed these protein sources (19 and 25, respectively)”	no association	Food security	“It can be concluded that this is a poverty-stricken community with household food insecurity where the caregivers changed their food consumption patterns to cope, resulting in compromised nutrition.”	20
2006	Steyn, N. P., Nel, J. H., Nantel, G., Kennedy, G., & Labadarios, D	Cross sectional	South Africa	English	n=2200 children	Children 1 to 8.9 years (12-108months)	no theoretical framework	“The dietary diversity based on 9 food groups by FAO 2)FVS defined as the number of food items consumed over a 24 hour period from a possible of 45 items. 3) NAR for: energy, % energy from fat, protein, iron, vitamin A, B1, B2,B3, calcium folic acid 4) MAR the measure of overall nutrient adequacy”	24hour dietary recall	“The items with highest frequency of consumption were from the cereal, roots, and tuber group (99.6%), followed tea, sugar, jam and sweets.”	DDS and NAR and MAR and FVS and MAR. Child anthropometric growth and DD	FVS,DDS, MAR	“FVS or DDS can be used as simple and quick indicator of the micronutrient adequacy diet”	20
2006	Odunayo, S. I., & Oyewole, A. O.	Cross sectional	Nigeria	English	n= 420 children were studied from 344 households consisting of 348 mothers and 344 fathers.	children =0 to 59 month of age	no theoretical framework	no	no	no	Formula and breast feeding and stunting and PEM	Children Anthropometric measurements	“Overcrowding, low maternal income and the use of infant formula feeds in children who have attained the age of 6 months and above were associated with a higher prevalence of wasting (P = 0.029, P = 0.031 and P = 0.005 respectively).”	20

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2006	Sawadogo, P. S., Martin-Prével, Y., Savy, M., Kameli, Y., Traissac, P., Traoré, A. S., & Delpeuch, F	Cross sectional	Burkina Faso	French	n=2466	Children aged 6-35 months	no theoretical framework	<p>“FVS the number of different food items consumed over the recall period.”</p> <p>“DD refers to the number of different food groups. food groups into account: cereals, roots and tubers, nuts and pulses, fruits and vegetables, meat and fish, eggs, milk and dairy products, and fat, Infant and Child Feeding Index (ICFI) based on an age specific scoring system that gives points for positive practices in terms of breast feeding, bottle feeding, meal frequency, and food diversification.”</p>	7 day recall and over 24 hours	no	“Mean anthropometric indices with ICFI or its components. ICFI distribution according to the socio-economic and demographic characteristics of the sample.”	Children Anthropometric measurements	“1) Food diversity index was associated with children’s nutritional status. 2) Scores concerning the consumption of selected food groups of particular interest rather than the global variety and diversity showed no significant relationship between the nutritional status of the children and the consumption of any food group.”	19
2008	Moursi, M. M., Arimond, M., Dewey, K. G., Trèche, S., Ruel, M. T., & Delpeuch, F	Cross sectional	Madagascar	English	n=702 eligible infants	Children 6-23months	no theoretical framework	<p>“4 different DDS were used. Two DDS summed a total of 8 possible food groups (DDS8 and DDS8-R). The 8 food groups were: grains, roots, and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry, and liver/organ meats); eggs; vitamin A-rich fruits and vegetables (&gt;130 retinol equivalents/100 g); other fruits and vegetables; and fats and oils.”</p>	24hour dietary recall	<p>“Grains, roots, and tubers were the main food source at a DDS of 1. Other fruits and vegetables were consumed by more than one-half of the children at a DDS of 2 and &gt;90% at a score of 4. Fats and oils were commonly consumed starting at diversity scores of 3 and higher. 2) Flesh foods were consumed by at least one-half of the children at DDS of 4 and higher, whereas for legumes and nuts, dairy products, vitamin A-rich fruits and vegetables, and eggs, this only occurred at DDS of 6 and higher. Patterns of food group consumption were similar for DDS8-R, DDS7, and DDS7-R.”</p>	Association of between BF and NonBF children and DDS	Child DDS	1)Mean dietary diversity was higher for non-BF infants than for BF infants	20
2008	Savy, M., Martin-Prevel, Y., Danel, P., Traissac, P., Dabiré, H., & Delpeuch, F	Cross sectional	Burkina Faso	French	n=600 women	Women age 20 to 59 years	no theoretical framework	Dietary Diversity=22 food groups reclassified into 9 food groups by FAO DDS9	24hour dietary recall	The mean DDS-9 and DDS-22 were 4.9 and 6.5 food groups, respectively	DDS by Anthropometric measurements; DDS and SES	women Anthropometric measurements	“The DDS-9 was not associated with the women’s socio-economic characteristics whereas the DDS-22 was higher when the women were younger, richer and had received at least a minimum education”	19

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2010	Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M. C., Deitchler, M., ... & Torheim, L. E	Cross sectional	Burkina Faso, Mali, Mozambique	French, Portuguese	Burkina Faso=178; Mali=102, Mozambique=409	Women 15-49 years of age	no theoretical framework	Dietary Diversity=9 food groups. Food group diversity indicator	24 hour dietary recall	“In the 2 urban West African sites, the proportion of total energy intake from starchy staples was lower than in the 2 rural sites, whereas energy contributions from fats, oils, and sweets were higher (P < 0.001 for all comparisons). In Mozambique, the proportion of energy intake from fruits and vegetables was higher than in other sites (P < 0.001 for all comparisons) due to high intake of mango, which provided 12% of energy intakes. Total carbohydrate as a percentage of energy ranged from 57 to 66% in the urban sites and was 82% in the rural sites. Conversely, total fat intakes were very low at 6–7% of energy in rural sites and ranged up to 32% in urban Mali.”	FGI by MPA	FGI	“All 8 FGI were correlated with MPA in all sites; regression analysis confirmed that associations remained when controlling for energy intake”	19
2011	Labadarios, D., Mchiza, Z. J. R., Steyn, N. P., Gericke, G., Maunder, E. M. W., Davids, Y. D., & Parker, W. A.	Cross sectional	South Africa	English	n=3287	Women 16 years and older	no theoretical framework	Dietary Diversity=9 food groups.	24hour dietary recall	“At the national level the mean DDS was 4.02. The most commonly consumed food groups were cereals/roots; meat/fish; dairy and vegetables (other than vitamin A rich). Eggs, legumes, vitamin A rich fruit and vegetables were the least consumed”	DDS by region; DDS by Living Standard Mean	Women DDS	“A comparison of geographic areas showed that urban formal areas had the highest mean DDS of 4.42 [CI: 4.34–4.50] while tribal areas had the lowest mean score; which was significantly lower than any other group (p < 0.05). There were significant differences in DDS by LSM (p < 0.05) with the lowest LSM group having the lowest DDS of 2.93 [CI: 2.81–3.05]”	20
2011	Lutter, C. K., Daelmans, B. M., de Onis, M., Kothari, M., Ruel, M. T., Arimond, M., ... & Borghi, E.	Cross sectional	Africa (the Democratic Republic of Congo, Ethiopia, Nigeria, and Sudan in Africa)	French, Amharic/English, Arabic/English	none reported/DHS dataset used	15-49 years mothers and infant 6-23 months	no theoretical framework	Child DDS=7 food groups	24hour dietary recall	Child 7 food groups, starchy staples was the food group most consumed.	DDS by region, DDS by WHZ	Child DDS	“When indicators of dietary diversity and minimum meal frequency were combined and reported as the minimum acceptable diet for breastfed children, only 21% of children aged 6 to 23 months met the minimum criteria; the low was 16% in countries of the African region; Undernutrition is more prevalent in rural than in urban areas.”	20
2011	Oldewage-Theron, W., & Kruger, R	Cross sectional	South Africa	English	women n=357	no	no theoretical framework	“The different dietary diversity measures, referred to as dietary variety, were calculated as follows: (1) overall food variety score (FVS) (simple count of food items); (2) food group variety score between all 9 food groups; and (3) a FVS within every food group”	7 day recall 7-d QFFQ	“Individual mean $\pm$ SD nutrient adequacy ratios ranging between $0.15 \pm 0.18$ and $0.95 \pm 0.19$ confirmed the poor dietary quality. Zero to 40 individual foods were consumed, but the mean $\pm$ SD food variety score was only $3.17 \pm 1.21$ , indicating low food diversity, as did the low dietary diversity score ( $2.82 \pm 0.99$ ) using 0 to 6 food groups”.	FVS by MAR; FVS by NAR; FVS by coping strategies	Child DDS	“The only NAR indicating sufficient intakes was for carbohydrates ( $1.84 \pm 0.77$ ). All the other NARs (mean $\pm$ standard deviation [SD]) ranged between $0.15 \pm 0.18$ for calcium and $0.95 \pm 0.19$ for iodine when measured against the ideal value of 1 (100%) for all nutrients. Only iodine showed a slightly lower than recommended mean NAR of $\geq 90$ to $< 100\%$ . Nutrients with a mean NAR of $\geq 60$ to $< 90\%$ were total protein, magnesium, phosphorus, and vitamins B1 and B12. All the other nutrients showed a very low mean NAR of $< 60\%$ . The MAR (%) of $50 \pm 29$ reflected the poor dietary intake and subsequent poor nutrient adequacy.”	17

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2011	Abrahams, Z., McHiza, Z., Steyn, N. P.	Cross sectional	SSA		n=40 countries in SSA	no	no theoretical framework	Stage of nutrition transition score ranging from 0 to 6	DES=Dietary Energy Supply	"The majority of countries (n = 26) used in the analysis had nutrition transition scores of zero and one"	DES by countries, Infant Mortality by Predictor variables	Nutrition Transition and Infant Mortality	"Most of them had a high prevalence of infant mortality, children that were stunted or underweight-for-age, small percentages of women that were overweight and obese, and low intakes of energy, protein, and fat. Countries with the highest scores include South Africa, Ghana, Gabon, Cape Verde and Senegal which had relatively low IMRs, high levels of obesity/overweight, and low levels of underweight in women, as well as high intakes of energy and fat"	19
2011	Bechir, M., Schelling, E., Moto, D. D., Tanner, M., & Zinsstag, J.	Cross sectional	Chad	French/Arabic	n=734 women	no	no theoretical framework	household dietary diversity	HDDs by nomadic or sedentary style; HDDS by BMI	"Low HDDS in both nomadic and sedentary group"	Malnutrition by HDDS, number of children and ethnic group	Women Anthropometric measurements	HDDS score were low among both nomadic and sedentary women in Chad	
2013	Nguyen, P. H., Avula, R., Ruel, M. T., Saha, K. K., Ali, D., Tran, L. M., ... & Rawat, R.	Cross sectional	Ethiopia	Amharic/English	n=875	children 6-23 months	no theoretical framework	Maternal Dietary Diversity=7 food groups/Children Dietary Diversity =7 food groups	24hour dietary recall	"The mean maternal DD was highest in Vietnam (4.6), followed by Bangladesh (4.1) and Ethiopia (2.8) the mean child DD was highest in Vietnam (4.4), followed by Bangladesh (2.9), and Ethiopia (1.7)"	"Child DD by maternal age, child age, proportion of male and female children, proportion of households headed by females, and number of children <5 y old in the household"	Child DDS	Maternal education was associated with both maternal and child DD; food security and socioeconomic status were associated only with maternal DD.	20
2013	Aemro, M., Mesele, M., Birhanu, Z., & Atenafu, A	Cross sectional	Ethiopia	Amharic/English	n=2836	children 6-23 months	no theoretical framework	Minimum Dietary Diversity. Minimum Meal Frequency. Adequate Dietary Diversity. Adequate Meal Frequency		"The proportion of children with adequate dietary diversity in study was 10.8%. Nearly half of children (44.7%) practiced insufficient meal frequency for complementary foods."	"DD by maternal education., DD by wealth DD by household sociodemographic and maternal and husband education"	Child DDS	"This result indicates the relationship between different food groups by age group which implies that food groups decrease as the child age decreases.  "Low level of maternal education was associated with dietary diversity and meal frequency compared to those mothers who had secondary and higher levels of education which is in line with other study findings."  This study revealed that children born from the richest households had 74% less chance to have inadequate dietary diversity compared with children from the poorest household (OR = 0.256, 95% CI: 0.142, 0.459)"	20
2013	Ali, D., Saha, K. K., Nguyen, P. H., Diressie, M. T., Ruel, M. T., Menon, P., & Rawat, R.	Cross sectional	Bangladesh, Vietnam, Ethiopia	Amharic/English	The Ethiopia baseline survey n=3422	children age 6-59month	no theoretical framework	Child DDS=7 food groups	24 hour dietary recall	"The percentage of children who had achieved minimum DD was also strongly associated with HFI category in all 3 countries in the expected direction: the more food-insecure the households, the less likely children achieved minimum DD"	HFI and child undernutrition; Child DD and anthropometric measures	Food Insecurity	"Undernutrition intensifies the need to explore the role of children's dietary quantity and quality as well as other potential mediators such as child illnesses or maternal depression through further research."	20

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2013	Drimie, S., Faber, M., Vearey, J., & Nunez, L.	Cross sectional	South Africa	English	n=487= 195 informal settlement 292 formal settlement	adult women and children	no theoretical framework	DDS=9	24hour dietary recall	“The mean DDS for the total study sample was just over 4, while the mean DDS for the respondents in the informal settlement was 3.2”	DD by region, DD by gender	WDDS	“Significantly more respondents living in informal settlements consumed a diet of low diversity (68.1% versus 15.4%, p<0.001). Respondents living in informal settlements consumed mostly cereals and, to a lesser extent, meat/poultry/fish, while respondents in the formal settlements consumed a more varied diet.”	19
2013	Belachew, T., Hadley, C., Lindstrom, D., Gebremariam, A., Lachat, C., & Kolsteren, P.	Cross sectional	Ethiopia	Amharic/ English	n=2084	Female adolescents	no theoretical framework	DDS=7, FVS, animal source foods	7 day food recall	Food security and sociodemographic	DDS by region, education, household income, and gender	WDDS	“Adolescent food insecurity is prevalent in the study area; our results also show that adolescents in rural areas were less likely to have a diversified diet, high FVS and high frequency of consuming ASF compared to adolescents that live in smaller towns or in the urban areas; High SES was associated with DDS”	20
2013	Tessema, M., Belachew, T., & Ersino, G	Cross sectional	Ethiopia	Amharic/ English	n=575 (mother-infant pairs)	6 to 23 months of age	no theoretical framework	DDS recoded dichotomize 4< or <4	24 hour dietary recall	“Consumption of beef, fish, and chicken was not frequent. Children consumed these flesh foods once per month or less throughout the year; whereas cereal-based food, mainly maize, was consumed daily by most of study subject”	“Time complementary food started, Frequency of breast feeding within 24 hours, consumption of extra food during pregnancy/lactation, feeding style, pre-lacteal feeding, bottle feeding, minimum meal frequency, minimum dietary diversity, minimum acceptable diet”	Children Anthropometric measurements	“It was found that those households that did not grow vegetables were 2.8 times more likely to feed their child below minimum dietary diversity than their counterparts (AOR=2.8; 95%CI: 1.33 -6.06). Whereas mothers who did not follow ANC during pregnancy were 2.8 times more likely to feed their child below minimum dietary diversity than those who follow ANC (AOR=2.8; 95%CI: 1.25 -6.14). The study also showed that mother who did not consume extra food during lactation/pregnancy were 2.6 times more likely to feed their child with low minimum dietary diversity than their counterpart (AOR=2.6; 95%CI: 1.30 - 5.35).”	20
2014	Mallard, S. R., Houghton, L. A., Filteau, S., Mullen, A., Nieuwelink, J., Chisenga, M., ... & Gibson, R. S	Cross sectional	Zambia (Urban)	English	n=811 infants(mother-infant pairs)	6 to 18 months	no theoretical framework	DDS=7 groups	24 dietary recall	no descriptive	“HAZ and WHZ, wealth, maternal education by DDS”	Child DDS	“Dietary diversity at 6 months of age was positively associated with both HAZ and WHZ at 18 months (both P ≤ 0.001) and mediated 13.4% and 25.9% of the total effect of maternal education on HAZ and , respectively, at 18 mo.”	19
2014	Faber, M., Laubscher, R., & Berti, C	Cross sectional	South Africa	English	n=316	6 to 24 months	no theoretical framework	DDS=7 groups	24 dietary recall	“Majority consumed cereals and tubers >85%; Legumes, flesh floods and other vegetables and fruit were consumed by 30-60% of children.”	DDS and nutrient density	Nutrition Density	“Higher dietary diversity was associated with higher nutrient density for protein and several micronutrients including calcium, iron, zinc.”	19
2015	Walsh, C. M., & Van Rooyen, F. C	Cross sectional	South Africa	English	n=886	between 25 and 64 years of age to participate	no theoretical framework	no	no	“In urban areas, green leafy vegetables were grown by 94% of households that did grow vegetables. In rural areas, green leafy vegetables, carrots and beetroot were most commonly planted. Of those who did produce crops, significantly more were in rural than urban areas and produced mainly sorghum, potatoes and maize, and had fruit trees (41% urban; 69% rural), mostly peach trees. As with crops and fruit trees,	“employment status, type of dwelling, water and sanitary conditions, assets, household income, and the proportion of income spent on food) and household food security (i.e., agriculture, crop and livestock ownership, the distribution of food between household members, the degree of hunger in the household, and the coping strategies implemented by households in times when experiencing food insecurity”	food insecurity	“Predictors of food security included vegetable production in rural areas and keeping food for future use in urban households. Microwave oven ownership was negatively associated with food insecurity in urban households and using a primus or paraffin stove positively associated with food insecurity in rural households”	20

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
										significantly more rural than urban households owned livestock (23% vs. 7%)."  "In both rural and urban households, chickens were the most common type of livestock owned."				
2015	M'Kaibi, F. K., Steyn, N. P., Ochoa, S., & Du Plessis, L	Cross sectional	Kenya	English	n=525	children no age mention	no theoretical framework	"The Household Food Insecure Access Scale (HFAS)= The nine-item scale uses a four-week recall period and was constructed to capture three larger dimensions of household food insecurity: anxiety and uncertainty about household food access: insufficient quality and insufficient food intake and its physical consequences or hunger. The maximum score for a household is 27. The higher the score, the more food insecurity (lower access) the household experienced NAR %= was calculated for each of 12 nutrients and energy, namely: vitamins A, B6, B12, C, B1, B2, niacin, folate; minerals- calcium, iron, and zinc and protein and energy."	24 hour dietary recall	"Dietary intake was low with the majority of households not meeting the RNIs for many nutrients/shows that the cereal group was consumed by nearly all children followed by the vitamin A-rich fruits and vegetables."  "The next group most commonly consumed was the dairy group. Consumption of meat and eggs were very low in both areas. The 10 most commonly consumed food items were maize meal, maize with beans, tea, kale, sugar, spinach and potatoes, tomatoes, boiled maize and chapattis in the dry season and tea, maize meal, maize and beans, milk, sugar, onions, mango, rice and beans, tomatoes and potatoes in the rainy season"	"Between agricultural biodiversity and dietary adequacy; Between agricultural biodiversity and household food security and between dietary adequacy and household food security. Furthermore, the effect of seasonality on household food security and dietary intake of the children was illustrated."	food insecurity	"The dietary intakes of macronutrients and micronutrients were low in this study with most of the preschool children not meeting the recommended nutrient intakes; A significant relationship was found to exist between the agricultural biodiversity score with all the nutrients investigated in the study with the exception of energy."	17
2015	Humphries, D. L., Dearden, K. A., Crookston, B. T., Fernald, L. C., Stein, A. D., Woldehanna, T., ... & Behrman, J. R.	Cross sectional	Ethiopia	Amharic/ English	n=1757	1 year, 5 year, 8 year	no theoretical framework	"Dietary Diversity=Food groups were combined into the following 7 categories at age 5 y: 1) starches (cereals, roots, and tubers), 2) meat (meat and fish), 3) eggs, 4) legumes and nuts, 5) dairy, 6) fruit and vegetables, and 7) fats and oils"	24hour dietary recall	"Children in food-insecure households had less diverse diets than children in food-secure households, at both ages 5 y and 8 y , although the food groups consumed varied among countries and across rounds/ Animal-source foods, such as meat, eggs, and dairy products, were less commonly eaten among food-insecure households in all countries, and the differences were almost always significant"	"maternal height, maternal age, rural residence at age 5, rural residence at age 8 y, food security; food insecurity and anthropometric measures; dietary diversity associated food insecurity."	Children Anthropometric measurements	"Chronically food-insecure households had significantly lower HAZs than households that were consistently food-secure, although BMI-Zs did not differ by chronic food-insecurity status"	20

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2015	Amugsi, D. A., Mittelmark, M. B., & Odoro, A.	Cross sectional	Ghana	English	1411 mothers and their index child aged 6–36 months were extracted	15–49year; children (age 6–36month)	no theoretical framework	Maternal dietary diversity (DD)= 15 food groups Child Dietary diversity= 15 food groups	24hour dietary recall	“Grains were the most commonly food group consumed by mothers (86%) and children (75%). More than half of both mothers and children also consumed other vitamin A fruits and fish. Vitamin A fruits, organ meat and dairy products were the least consumed food groups by both mothers and children (Table 3). Mothers consumed more food groups (mean DD = 5.45±2.28) than did children (mean DD = 4.67±2.98)”	“Child DDS and maternal DDS, taking into account child age and sex, maternal factors (age, education, occupation, literacy, empowerment, number of antenatal visits as an indicator of health care use), household Wealth Index, and urban/rural place of residence.”	Child DDS	“Maternal antenatal attendance was negatively associated with child DD in this analysis. In the final model (model C), wherein maternal DD was included, a statistically significant positive association between child and maternal DD was observed. A difference of one food group in mother’s consumption was associated with a difference of 0.72 food groups in the child’s food”	19
2015	Issaka, A. I., Agho, K. E., Page, A. N., Burns, P., Stevens, G. J., & Dibley, M. J.	Cross sectional	Ghana, Liberia, Nigeria, Sierra Leone (Anglophone countries), Benin, Burkina Faso, Cote d'Ivoire, Guinea, Mali, Niger and Senegal (Francophone countries)	—	34 999 children: 12 623 in the Anglophone countries and 22 376 children in the Francophone countries	6–23months of age	no theoretical framework	Child Dietary Diversity=7 food groups	24 hour dietary recall	“The average rate of minimum dietary diversity for the Anglophone countries was 32.0% while that of the Francophone countries was only 10.6%, While the minimum meal frequency rates ranged between 42.0% (Sierra Leone) and 55.3% (Nigeria) for the Anglophone countries, the corresponding rates for the Francophone countries ranged between 25.1% (Mali) and 52.4% (Niger)”	No association; only descriptive results	Child DDS	“Anglophone and Francophone countries reported alarmingly low rates of minimum acceptable diet, with the two groups of countries averaging rates of 19.9% (Anglophone) and 5.5% (Francophone)”	17
2015	Mchiza, Z. J., Steyn, N. P., Hill, J., Kruger, A., Schönfeldt, H., Nel, J., & Wentzel-Viljoen, E	Review	South Africa	English		adult women	no theoretical framework	Mean Energy intake	24hour dietary recall 4 h recall, food frequency, and weighed dietary record, dietary history to record adult intakes.	“The most commonly deficient food groups observed are fruit and vegetables, and dairy”	MEI by gender, age, geographic location, rural vs urban	WDDS	“In rural areas, access to healthy foods also remains a problem. A national nutrition monitoring system is recommended in order to identify dietary deficiencies in specific population groups”	20
2015	Ogbo, F. A., Page, A., Idoko, J., Claudio, F., & Agho, K. E	Review	Nigeria	English	79953 children	6–23months	no theoretical framework	Child DD=7food groups	review	Starchy staples food group mostly consumed.	DDS and sociodemographic variables ( education, wealth index, antenatal visits)	Child DDS	“Minimum dietary diversity for children aged 6–23 months worsened from 26% in 2003 to 16% in 2013. Minimum meal frequency improved from 43% in 2003 to 56% in 2013 and minimum acceptable diet worsened from 11% to 9%. Mothers with higher educational achievement and mothers from wealthier households were more likely to meet minimum dietary diversity compared to mothers with no schooling and mothers from poorer households, respectively”	20

Year	Author	Study type	Country	Language	sample size	Age Group	Theoretical Framework	Dietary Diversity Approach (indicator)	Method and reference group	Descriptive Dietary Diversity Findings	Types of validation or association study	Outcome Variable	Main Findings	STROBE Score
2015	Steyn, N. P., de Villiers, A., Gwebushe, N., Draper, C. E., Hill, J., de Waal, M., ... & Lambert, E. V.	RCT	South Africa	English	500 in intervention and 498 in control	grades 4 to 6	no theoretical framework	DD=9 groups, Sugar Intake Score, Fat Intake Score	24hour dietary recall	“All of the learners (100 %) in the intervention group consumed at least one item from the cereal group in 2009, 2010 and in 2011, followed by meat 86.7 to 92.1 %; fats 71.9 to 91.0 % and dairy 70.3 to 75.8 %, in 2009 to 2011, respectively. Intake of eggs was lowest (15.1 to 11.7 %) and for the fruit and vegetable categories. Legumes and nut intake decreased from 53.2 % in 2009 to 39.9 % in 2011.”	no	Child DDS	“Most learners in intervention and control groups consumed four or five food groups per day (Table 3). In the intervention schools, 49 % had a DDS ≤4 (poor diversity) in 2009 which increased to 79 % in 2010 and decreased again to 36 % in 2011, showing considerable improvement. In the control schools the percentage DDS ≤4 remained fairly similar over this time. In 2011 the intervention schools had considerably less learners with a DDS ≤4 than the control schools.”	20
2015	Beyene, M., Worku, A. G., & Wassie, M. M.	Cross sectional	Ethiopia	Amharic/ English	920 infants	6-23months and their mothers	no theoretical framework	DD=7 groups	24 hour dietary recall	“Grains, roots and tubers were eaten by 80.2% of children.”	“The educational status of a mother, age of a child, birth order of index child, area of residence, home gardening and satisfactory media exposure of a mother were significantly associated with providing the minimum dietary diversity after controlling for other predictors in the model”	Child DDS	“urban areas were reported higher practice of minimum dietary diversity [AOR 2.09; 95 % CI (1.12, 3.93)] as compared to those children born from mothers who lived in rural areas. This indicated the relationship between different food groups by age group which implies that food groups decrease as the child age decreases”	20
2015	Herrador, Z., Perez-Formigo, J., Sordo, L., Gadisa, E., Moreno, J., Benito, A., ... & Custodio, E	Cross sectional	Ethiopia	Amharic/ English	886 school aged children in rural and urban	school aged children	no theoretical framework	DD=9 groups	24hour dietary recall	“The diet in rural areas was mainly based on cereal, roots and tubers (99.6%) and pulses and legumes (90.4) while children living in urban settings had a more diversified diet”	“sex, age, sex head household, age head household, religion head household, number of people in household, number of children in household, SES, Community Endowment Index”	Child DDS	“Diet among school-aged children in Libo Kemkem and Fogera districts lacked diversity, and that the intake of foods from animal sources was low, especially among rural girls.”	20