FACTORS ASSOCIATED WITH STUNTING AND ITS PREVALENCE AMONG CHILDREN BELOW 5 YEARS OLD IN MUSANZE DISTRICT OF RWANDA

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DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY

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I, declare that this dissertation is my original work and has not been presented to any institution for any degree award.

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DEDICATION

This dissertation is dedicated to my family and friends which endured my absence during the whole period of my postgraduate studies.

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ABSTRACT

Stunting among children below five years old affected 44% in Rwanda and more than 61% in Musanze District in 2012. The main objective was to establish the prevalence of stunting and its associated factors among children below five years old in Musanze District of Rwanda.

A cross sectional study was carried out in Musanze District where a multi-cluster sampling was applied to select 529 children systematically from 30 clusters. Data were collected using structured questionnaire. SPSS and WHO Anthro computer software were used for data analysis. A binary logistic regression was used to find out the model of contributing factors. The level of statistical significance was set at $p<0.05$.

The prevalence of stunting was found at 41%. An increased risk of stunting was associated with household headed by female (OR=1.370, P≤0.001), absence of kitchen garden (OR=1.436, P≤0.001), nonuse of industrial fertilizer (OR=1.228, P≤0.001), mother aged between 20 and 34 years old (OR=2.036, P≤0.001), less than four times prenatal consultations (OR=1.477, P≤0.001), children aged 6-23 years old (OR=3.358, P≤0.001), not exclusively breastfed (OR=2.319, P≤0.001), not continued to breastfeed (OR=1.507, P≤0.001), low dietary diversity (OR=1.981, P≤0.001), and absence of hand washing facility (OR=2.742, P≤0.001).

The present study showed that the following factors were found to be reducing risks of stunting. These are monogamous households (OR=0.430, P≤0.001), high wealth index (OR=0.478, P≤0.001), education of the mother from primary to the university (OR=0.256; P≤0.001), (OR=0.356; P≤0.001), (OR=0.357, P≤0.001), (OR=0.124, P≤0.001), revenue productive activities of the mother such as trading, art craft and

salaried jobs (OR=0.442, P≤0.001) (OR=0.359, P≤0.001), (OR=0.620, P≤0.001), female child (OR=0.418, P≤0.001), use of safe water (OR=0.597, P≤0.001), household without open defecation (OR=0.810, P≤0.001), and no waste lying around (OR=0.287, P≤0.001).

The prevalence of stunting among children below five years old in Musanze District of Rwanda was 41%. The factors associated with stunting are polygamy, food insecurity, education and occupation of the mother, poor hygiene, poor care giving and poor feeding practices. The stakeholders should focus on above mentioned factors to fight against stunting.

Key words: Children below five years old, Stunting, Nutrition, Factors, Musanze District

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List of abbreviations

CBHPP: Community-Based Health Promotion Program

CFSVA: Comprehensive Food Security and Vulnerability Analysis

ENA for SMART: Emergency Nutrition Assessment

GDP: Gross Domestic Product

GMT: Greenwich Mean Time

MDGS: Millennium Development Goals

MUAC: Mid Upper Arm Circumference

NAP: Nutrition action plan

NFNSP: Rwanda National Food and Nutrition Policy, Rwanda National Food and Nutrition Strategic Plan

PEPFAR: President's Emergency Plan for Aids Relief

PNBC: Programme de Nutrition Basée sur la Communauté

PSTA: Plan strategique pour la transformation de l'agriculture

ROR: Republic of Rwanda

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

UNICEF: United Nations Children's Fund

USAID: United States Agency for International Development

WASH: Water Sanitation Hygiene

WFP: World Food Program

WHO: World Health Organization

Operation definitions

Household: This involves of one or more individuals either related or unrelated living together, occupying a housing unit and sharing daily meal.

Hygiene: It is a set of practices performed to keep oneself and their surroundings clean for the promotion and preservation of good health.

Nutrition status: Individual's nutrition condition manifested by the state of the body with respect to each nutrient and to the overall state of the body measurements and conditions.

Malnutrition: A health condition in which a diet does not provide sufficient calories and protein for growth and maintenance of the body or inability to fully utilize the food they eat due to illness.

Under nutrition: consequence of inadequate food intake which includes being too short for one's age (stunting), underweight for one's age, dangerously thin for one's height (wasting) and deficient in vitamins and minerals (micronutrient malnutrition).

Sanitation: The development of infrastructures and equipment relating to the provision of safe water, keeping places free from dirt, infection, disease and adequate waste (excreta, sewage and solid waste) disposal.

Stunting: When one's height for age Z score is below minus two standard deviations compared to the median height for age of reference population

Z score: is defined as how many standard deviations of the values of a given child differ from the mean of the reference population.

CHAPTER 1 INTRODUCTION

1.1 Background of the study

Nutritional status of children below five years old is characterized by gender, age, dietary intake, household characteristics, and their health status and influenced by underlying factors such as food security and community infrastructure including water, hygiene and sanitation, local market conditions and other factors such as health cost and availability of household resources and income (Fedorov and Sahn , 2005)**.** Each year 45% of total mortality of children below five years old worldwide is attributed to malnutrition (Dangour et al., 2013).

Under nutrition involves being dangerously thin for one's height (wasting), low weight for one's age (underweight), too short for one's age (stunting), dangerously thin (acutely undernourished) and deficient in vitamins and minerals (Black et al., 2010). Getting stunted in early life is linked with adverse consequences, including educational performance and cognition deficiency, low adult productivity, increase of infection possibility, limits in physical capacity, reproduction system and its process, and increase in mortality risk (Victora et al., 2008) and (Black et al., 2008). Scientists have estimated that malnourished children are at risk of loosing up to 10% of their life time earning potential, and malnutrition can cause countries risks of losing up to 3% of GDP (Republic of Rwanda, 2013).

Worldwide, 162 million children below five years old were stunted in 2012, 56% of them lived in Asia and 36% in Africa, (WHO and UNICEF, 2009).

In developing countries, malnutrition is an important public health problem and the prevalence of malnutrition was estimated to be between 4% and 46% with 1% to 10% being severely malnourished (Black et al., 2008).

According to National Institute of Statistics of Rwanda (2012) stunting in children below five years old is at 44% (NISR, MOH, 2010), and a CFSVA reported that in Musanze District, stunting is above 61% (MINAGRI ET WFP, 2012).

1.2 Problem statement

Prevalence of stunting in Musanze District is above 61% (MINAGRI ET WFP, 2012). The target of the Millennium Development Goal was to lower stunting to 24.5% by 2015 (National Institute of Statistics of Rwanda, 2012). Undernourished children are less able to resist infectious diseases and are more likely to die young, and if they survive with the under nutrition in early years, they struggle to fulfill their full physical and cognitive development, and they thus continue to be less able to escape from poverty (UNGEI, 2010).

Despite the presence of several governmental and non-governmental initiatives such as vitamin A distribution, Growth monitoring, de-worming programs, Programme de Nutrition Basée sur la Communauté (PNBC- Community based nutrition Program), Water Sanitation Hygiene (WASH), Community-Based Health Promotion Program (CBHPP), and the natural richness of the area, which could have contributing to the improvement of nutrition status, hygiene and sanitation, the prevalence is still high. There might be other factors influencing the nutrition status of children below five years old.

This study therefore sought to find out the contributing factors in order to fight stunting more efficiently.

1.3 Justification

This study was important to provide further understanding of factors that contribute to the prevailing high level of stunting. Knowing these factors will help in development of effective strategies to combat malnutrition in Rwanda, especially where stunting prevalence is high. The Country will produce people who do not have cognition deficiencies, yet with reduced infection and mortality risk, increased physical capacity and child bearing. This will provide policy makers some information which will help them in better planning and decisions making based on scientific facts. It will reduce as well the cost of interventions that focus on nutrition and it will accelerate the progress to achieve the Millennium Development Goals which will eventually lead to an increase in the Economy of the Country.

1.4 Aim

The aim was to determine the association between stunting of children below five years old and medical, nutritional and socio-economic factors in Musanze District.

1.5 Purpose

The purpose of the study is to contribute to the improvement of nutrition status of children below five years old by identifying associated factors.

1.6 OBJECTIVES

1.6.1 Main Objective

To establish the prevalence of stunting among children below five years old and its associated factors in Musanze District of Rwanda.

1.6.2 Specific objective

1. To determine the prevalence of stunting among the children aged below five years.
2. To determine the socio-demographic and economic characteristics of households of children aged below five years.
3. To determine the food consumption practices of the children aged below five years.
4. To determine morbidity patterns of children aged below five years.
5. To evaluate hygiene and sanitation status among households of children aged below five years.

1.7 Hypothesis

There is a high prevalence of stunting among children below five years old in Musanze District which is associated with poor socio-demograpic and economic characteristics, poor hygiene and sanitation, low dietary intake and morbidity patterns of children.

CHAPTER 2 LITERATURE REVIEW

1.1 2.1 Malnutrition

Malnutrition is a wide term used to refer to poor nutritional health. It embraces both under nutrition and over nutrition but in worldwide health it refers more generally to under nutrition rather than over nutrition (Semba, 2008). Under nutrition exists in form of acute malnutrition (wasting and nutritional edema), chronic malnutrition (stunting), micronutrient malnutrition and inter-uterine growth restriction (i.e. poor nutrition in the womb) (Kenya MOH AND MPHS, 2010). In this research we will focus on stunting, which is a chronic form of under nutrition.

2.1.1 Indicators of child stunting

2.1.1.1 Height or length-for-age

Low height or length for age is the indicator of stunting, defined as arrested or decelerated or poor linear growth, and is a good indicator of long-term under nutrition (Shapiro-Mendoza et al., 2005). Stunting is the consequence of many health conditions and determining factor, including prenatal, intra-uterine and postnatal malnutrition (de Onis et al., 2012). Stunting in early stages of one's life is associated with adverse functional effects, including cognition deficiencies, educational performance, low adult incomes, loss of productivity and, when accompanied by too much weight increase later in childhood, increased risk of nutrition-related chronic diseases (Black et al., 2008). Early interventions can prevent these outcomes and also decrease the risk of maternal mortality and short and long term disability due to obstructed labour (Merchant et al, 2001). Stunting remains a problem of greater magnitude than wasting or underweight,

and it more accurately reflects nutritional deficiencies and illness that occur during the most critical periods for growth and development in early stages of one's life. To say a child is stunted, the Z score of height or length for age should be less than – 2 SD of the WHO Child Growth Standards median (WHO and UNICEF, 2009).

2.1.2. Determinants of children stunting

Socio-demographic and economic characteristics of the population

A comparative study conducted in Mexico indicated that extreme poverty of families is positively associated with stunting among the under-five years old children (Reyes et al., 2004). A study conducted in Bangladesh revealed that malnutrition rate was twice developed among the poorest families than richest ones and children of lower income families were more likely to be undernourished than children of higher income families (Giashuddin et al, 2005).

In Zambia, it has been shown that children from formally educated families were nutritionally healthier compared to those from families with low or informal education (Zondag et al, 1992). Another study realized that parental illiteracy and low monthly income were strongly associated with acute malnutrition among the under five year old children in Bangladesh (Hossain et al, 1999). According to the research conducted in Nepal, poor socio-economic status was found to be contributing to stunting (Ahmed O., 2011). The results from Wibowo et al. (2015) confirmed that the incidence of an inequality in food distribution between children and mothers increases the risk of malnutrition in the household.

Feeding practices

Espo et al (2002) showed that inadequate infant feeding practices were positively associated with severe stunting at 12 months of age in the rural area of Malawi.

Gouado (2014) found that exclusive breastfeeding practice was rare, as well as inappropriate complementary feeding practices in environment with very poor hygienic conditions. He realized as well that the tendency to introduce early complementary feeding to the young children was due to the beliefs of the mothers that their milk was not sufficient. Yet others think that they don't have enough time to breastfed their children. WHO recommends early initiation to breastfeeding within one hour of birth; to continue exclusively breastfeed for the first 6 months of life; to introduce complementary (semi solid, solid and soft) foods at the age of six months and continue to breastfeed up to two years of age or beyond (Black et al., 2013).

Delayed introduction to complementary feeding, trust in diluted milk and delay on giving to the child the family food have been mentioned to contribute to low energy and nutrient intake of children (Latham, 1997; Moursi et al., 2008). In Nigeria, inappropriate weaning, poverty, poor supplementary feeding and illness were found to be strongly associated with under nutrition (Madusolumuo & Akogun, 1998). In a study conducted at Beta-Israel found that deprivation of colostrum, duration and frequency of breastfeeding, feeding priori-lactation, age of introduction of complementary feeding and method of feeding, type of food were among the risk factors for under-five malnutrition (Asres & Eidelman, 2011).

Hand washing and personal hygiene

Globally, improvement of hygiene and sanitation can prevent at least 9.1% of the disease burden or 6.3% of all deaths of children in developing Countries. The improvement of water quality and water supply, hygiene and sanitation has the potential to prevent 33% of diarrheal diseases (Hill et al, 2004). In a study conducted on prevalence and determinants of malnutrition among children below five years old of farming households in Kwara State of Nigeria, malnutrition was significantly associated with accessibility to safe water and presence of toilet at household level. (Babatunde et al, 2011). Hand washing with clean water and soap is one of the most effective and cheapest measures against gastrointestinal infection.

Food hygiene

Hazardous microorganisms are found everywhere in animals, soil, water, and people. During food handling i.e. harvesting, transportation, keeping, storing, and preparation, they can be carried on hands, wiping cloths, and utensils. Any contact by such contaminated item can transfer these microorganisms to food, causing food-borne diseases particularly among children, the elderly, and immuno compromised people like HIV positive. (Nkenfou et al, 2013). Unclean utensils were also considered a source of food contamination (Mannan & Rahman, 2011). The five keys to food safety guidelines will keep everyone healthy. These include, to stay clean, to separate cooked and uncooked foods, to cook thoroughly, to keep food at appropriate and safe temperatures and to use safe water and raw materials (Val Hiller et al, 2009)

Sanitation

Improvement of sanitation targets to prevent the spread of hygiene related disease and promote health through hygienic and safe waste management (Bourne et al, 2013). Adequate sanitation is vital for a safe and healthy childhood and it is almost impossible to maintain good hygiene conditions without safe water and waste disposal system (Bourne et al, 2013). Poor sanitation is directly related with diarrhoea diseases, cholera, bilharzia, malaria, worm infestations, eye infections and some skin diseases. These diseases compromise children's nutritional status (Bourne et al, 2013).

Morbidity pattern of children

The interaction of under nutrition and infectious diseases is the major cause of morbidity and mortality in children in Africa, Asia and Latin America (Latham, 1997). The synchronized presence of both under nutrition and infectious diseases has more serious consequences for both children and adults (Latham, 1997). Yet most of those infectious diseases are preventable.

Agriculture and nutrition status of children

Food and nutrition security comprises reaching adequate dietary diversity, quality and quantity (UNSCN, 2013). Nutrition sensitive agriculture programs are likely to improve nutrition outcomes (Ruel et al, 2013). Scaling up nutrition will impact the availability and consumption of a sufficient variety of nutritious foods. Agricultural productivity has increased, but child stunting continues to be unchanged or even increased due to inadequate quality of diet, and poor nutritional knowledge of household caregivers (Wiggins, 2014).

CHAPTER 3 STUDY DESIGN AND METHODOLOGY

3.1 STUDY DESIGN

A cross sectional study design using quantitative approach was used to address the research objectives of this study.

3.1.1 Study site

The study was carried out in Musanze District/Northern province of Rwanda. Musanze District was purposively selected among Districts of Northern Province supported by the study funder.

3.1.2 Description of Musanze District

Musanze District, one of the 5 Districts of the Northern Province, was created by the organic law number 29/2005 dated on 12/23/2005 related to administrative entities of the Republic of Rwanda. Its main town is Ruhengeri which is one of the largest cities in Rwanda. It is boarded in the North by Uganda and Democratic Republic of Congo through Virunga National Park, in the South by Gakenke District, in the East by Burera District, in the West by Nyabihu District. Virunga Park has a total area of 60 km^2. It has also Lake Ruhondo with an area of 28 Km^2 in the south west. Musanze District is divided into 15 Sectors (Imirenge) namely Busogo, Cyuve, Gacaca, Gashaki, Gataraga, Kimonyi, Kinigi, Muhoza, Muko, Musanze, Nkotsi, Nyange, Remera, Rwaza and Shingiro. Those Sectors are divided into 68 Cells and 432 Villages (Imidugudu). The size of population is 350,069 inhabitants in 70,830 households. The gross surface area is 530.4 km^2 while net surface is 442.4 km^2. The gross density in Musanze District is 593 persons per km^2 but the real density is710 persons per km^2. Musanze District is geographically located at latitude 1°30’6; 94″S, longitude 29°37’59; 75″E. The average temperature is 18°C and rainfall average is1,000-1,200 mm per year (Musanze District, 2013).

3.1.3 Climate

Elevated at 1,850 m of altitude, Musanze has one of the most agreeable climates in Rwanda. Warm and breezy days are followed by cooler nights in which it is not surprising to find most Rwandans in a light sweater. April and May bring about the heaviest rains, whereas October and November have a much more moderate rainy period. Average amount of rainfall during the rainy seasons is 1,000-1,200 mm per month (Musanze District, 2013).

3.1.4 Geography

Musanze District is the most mountainous region of the Country and contains the major part of the Volcanoes National Park. Five of the eight volcanoes of the Virunga chain are Muhabura, Gahinga, Sabyinyo, Bisoke and Karisimbi and are within the District boundaries. Karisimbi is the tallest peak in Rwanda at 4,507 m and is the sixth tallest peak in Africa. The Rwanda-Democratic Republic of Congo border crosses over the peak of Karisimbi (Musanze District, 2013).

3.1.5 Vegetation

With the majority of the population of Musanze District working in agriculture, most of Musanze's jagged countryside has been stripped of its foliage and farmed to grow pyrethrum, sorghum, potatoes, beans, etc... The Volcanoes National Park is still a rich and luscious habitat of green vegetation especially bamboo, and animal life, but farmers outside of the park have taken over the land all the way up to the park boundaries (Musanze District, 2013).

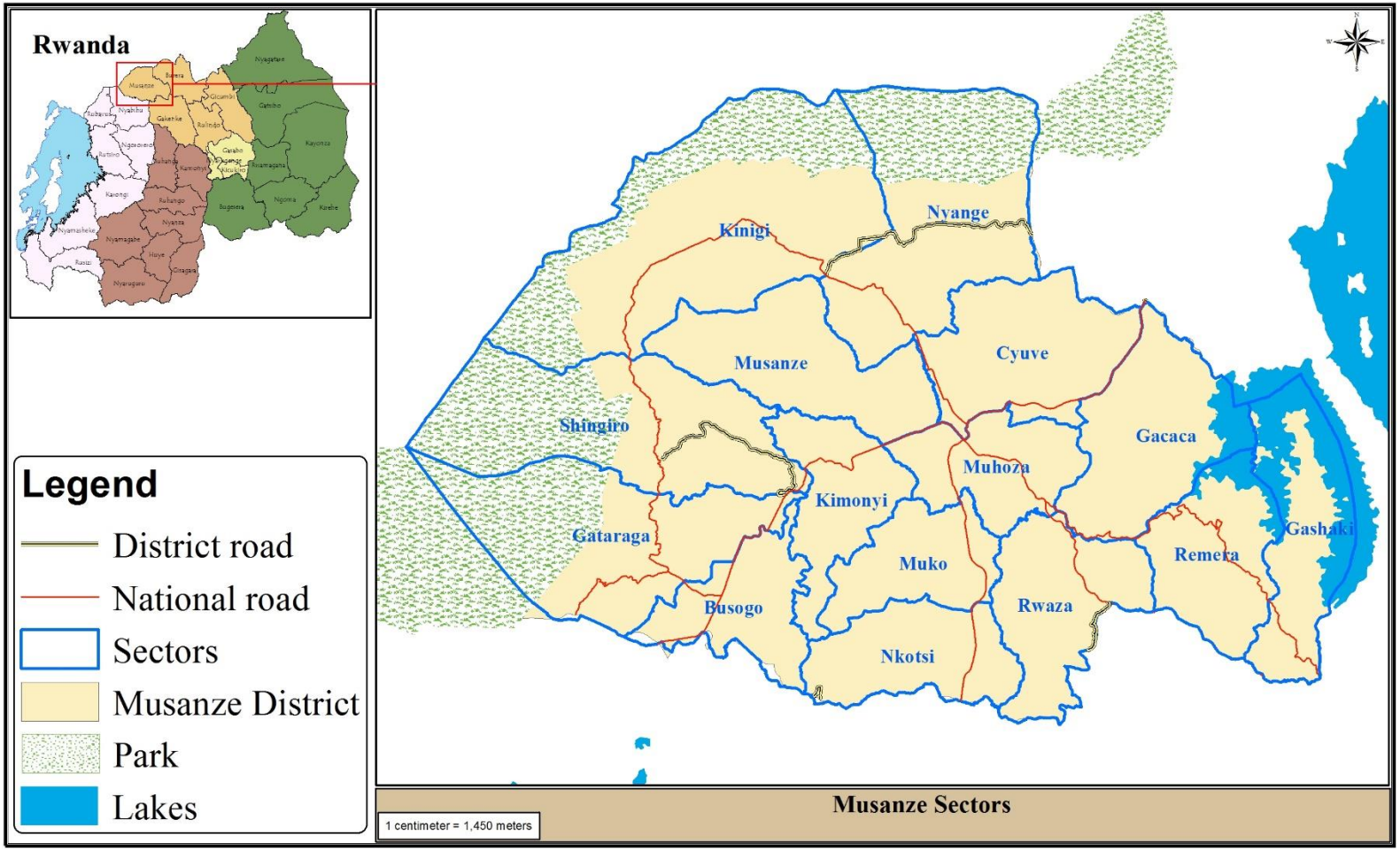

Figure 1: Map of Musanze District

3.1.6 Study population

The study population consisted of all children below five years old in Musanze District in Rwanda.

3.2 METHODOLOGY

3.2.1 Sampling

3.2.2 Sampling frame

Sampling frame was 42770 children below five years old in Musanze District.

3.2.3 Sampling procedure

Multi cluster sampling was applied. Primary units for the study were administrative Villages (Imidugudu) which were selected systematically. From each selected Village, exhaustive lists of all eligible candidates were developed in collaboration with Community Health Workers. Once lists were available, units were selected using a systematic random sampling with proportionate allocation.

3.2.4 Sample size determination

The formula used to calculate sample size is $n = \frac{z^2 pq}{d^2}$ (Fischer, 1991) where:

- n is the desired sample size when the population is greater than 10000
- z is the a abscissa of the normal curve that cuts off an area α at the tails if the confidence level is 95%, z=1.96
- p is the prevalence of stunting 61% and q =1- p

– d is the desired level of precision in this case, 5%

$$n = \frac{1.96^2(0.61)(0.39)}{0.05^2} = 335.5 \cong 336$$ children below five years old

The application of design effect of 1.5 and none response rate of 5% give

$n_f = 529$ children below five years old

3.2.5 Inclusion criteria

Only children aged of 0 to 59 months in Musanze District were considered.

3.2.6 Exclusion criteria

Eligible subjects who declined to consent, mothers or caregivers who appeared to have a mental illnesses as well as children with mental and physical disability were excluded from the study.

3.2.7 Data collection

3.2.8 Data collection tools and instruments

Data were collected using a structured questionnaire, combined with an anthropometric data sheet and an observation checklist, food frequency questionnaire. Measurement instruments and materials used were scale and length board. Data collection tools used was adapted from the Comprehensive Food Security and Vulnerability Assessment & Nutrition Survey Rwanda.

3.2.9 Recruiting and training research assistants

30 students of Human Nutrition and Dietetics level 4, College of Medicine and Health Sciences of University of Rwanda were recruited as enumerators and trained for 5 days, three days for theory, one day for practice, one day for correction of the tool. Also 30 community Health workers from their respective villages were recruited as field guides.

3.2.10 Pretesting of questionnaires

A pretest was carried out using 30 households in Karongi Districts and the information helped to rectify and to update the used tools.

3.2.11 Data collection process

To collect data, research assistants used a structured questionnaire, and an observation checklist. Quantitative primary data were collected using a data collection tool installed in Tablets with Android operating system in order to minimize data entry errors and reduce the time between data collection and data analysis. Collected data were sent to a central system where quality checks were done on a regular basis. Upon the completion of the fieldwork, all data files were assembled and consolidated for consistency and completeness. A data dictionary was created for the data to be exported into SPSS formats for final cleaning and analysis.

Community health workers helped to identify selected households. All activities of data collection were supervised by two supervisors coordinated by the principal investigator.

Socio-demographic characteristics and socio-economic information

Data on, sex, family size, education of parents, occupation and income were collected to provide background information about households and their children.

To define wealth categories, a set of characteristics proposed by the government has been followed. The following are the characteristics:

Table 1: Characteristics for wealth categories

Category	Characteristics
Extremely poor	Those who need to beg to survive. They have no land or livestock and lack shelter, adequate clothing and food. They fall sick often and have no access to medical care.
Very poor	The main difference between the "very poor" and the "extremely poor" is that this group is physically capable of working on land owned by others, although they themselves have either no land or very small landholdings, and no livestock.
Poor	These households have some land and housing. They live on their own labour and produce, and though they have no savings, they can eat, even if the food is not very nutritious. However they do not have a surplus to save or sell in the market, their children do not always go to school and they often have no
Resourceful poor	This group shares many of the characteristics of the poor but, in addition, they have small ruminants and their children go to primary school.
Food reach	This group has larger landholdings with fertile soil and enough to eat. They have livestock, often have paid jobs, and can access health care.
Money reach	This group has land and livestock, and often has salaried jobs. They have good housing, often own a vehicle, and have enough money to lend and to get credit from the bank. Many migrate to urban centers.

Source: (Government of Rwanda, 2002)

Index child information and child feeding practices

A structured questionnaire (Appendix 3) was administered and filled with data like name of the index child, date of birth, age, sex, and breastfeeding status. Those on complementary feeding, time of introduction of food other than breast milk, number of feeds in a day, child's food preparation and food consumption frequency were recorded. A food frequency questionnaire (Appendix 3) was used to assess the adequacy of the diet fed to infants. Age of children and vaccination history was obtained by reading the vaccination card of the children.

Anthropometric measurements

Height: A portable stadiometer was placed vertically or horizontally on a stable level surface. The measurements were taken without shoes and head covering, standing or lying on the measuring board straight whith feet together, knees straight, heels, buttocks and the shoulder blades in contact with the surfaces of the stadiometer, arms straight at the side and the shoulder relaxed. The head still kept in position, the movable headpiece was able to be moved downward gently and firmly until it touches the head and compressing hair. The measurement was taken to the nearest 0.1 centimeter. The average was calculated from two measurements that were taken and did not differ by more than 0.5 cm.

Weight: A portable scale was used to measure weight, placed on flat surface, checked for accuracy and verified using a 2 kg standard at the beginning of every session. Children were helped to wear only lightweight clothing (excludes shoes, socks, and jackets). The average was calculated from two measurements that were taken and did not differ by more than 0.5grams.

Food frequency questionnaire

The food frequency questionnaire (Appendix 3) was used to enable the investigator to establish how often certain foods were consumed by children.

3.2.12 Data quality control and assurance

Calibration of scales was done every day and during weighing, the scale was checked for accuracy and verified using a 2 kg standard at the beginning of every weighing session. For all measurements taken, the average was calculated from two taken measurements. The completed questionnaire was examined in the field to check on the completeness of data, consistency of answers and measurements taken. The principal investigator made direct and frequent field supervision of data collection. The research assistant received all required assistance in case of necessity. Supervisors were consulted for any assistance.

3.2.13 Data handling and analysis

Descriptive analysis helped to generate information about the characteristics of the population. Data collected from the questionnaire was checked, verified and entered into computer database of SPSS 21. WHO Anthro helped to generate Z scores of children which were transferred into SPSS for analysis. As cluster sampling system was used, a statistical weight adjustment was made by considering two leves of clusters: village and household; and each weight were assigned to its appropriate village.

$$PI_{Village} = \frac{N_{selectedvIlages}}{N_{Villagesi/\ District}} \qquad PI_{Household} = \frac{N_{selectedhausehold/\ village}}{N_{Household}} \qquad Weight = \frac{1}{(PI_{Village} * PI_{Household})}$$

$PI_{village}$= probability if inclusion in a village

$PI_{Household}$= probability if inclusion in a household

$N_{selected\ villages}$= Number of selected villages in all Musanze District

$N_{village/District}$= Number of all villages in Musanze District

$N_{selected\ households/villages}$= Number of selected household in each selected villages

$N_{households/village}$= Number of all household in each selected villages in Musanze District

For that, weighted total number of children below five years old in Musanze District was 38620.

To describe the demographic, socio-economic data and hygiene status, data were grouped and processed according to descriptive statistic and cross tabulation.

To determine Household hunger indicators, three questions were asked (reference question number 24, 25 and 26 from the Appendix 3). The values of three questions were summed for every household to determine the household hunger score then, each household obtained a new score between computed 0 and 6. At the end those generated values were used to determine the household hunger score indicators where score between 0 and 1 are interpreted as there is little or no hunger in a household, score between 2 and 3 are deduced as there is moderate hunger in a household and score between 4 and 6 are inferred as there is severe hunger in a household (Ballard et al, 2011).

For feeding practices of children below five years old, indicators were calculated as recommended in WHO and UNICEF, 2007.

Early initiation of breastfeeding: Percentage of children born in the last 24 months who were put to the breast within one hour of birth.

Exclusive breastfeeding under 6 months: Percentage of infants between 0–5 months of age who are fed exclusively with breast milk.

Continued breastfeeding at 1 year: Percentage of children between 12–15 months of age who are fed breast milk.

Introduction of solid, semi-solid or soft foods: Percentage of infants between 6–8 months of age who receive solid, semi-solid or soft foods.

Minimum dietary diversity: Percentage of children between 6–23 months of age who received at least four or more food groups. To determine minimum dietary diversity, seven food groups energy food (Starches, legumes and nuts), dairy products (milk, yogurt, and cheese), flesh foods (meat, fish, poultry and liver/organ meats), eggs, vitamin-A rich fruits and vegetables, other fruits and vegetables. Households which had children who consumed less than 4 food groups were categorized in low dietary diversity while those who consumed 4 and more food groups were categorized as high dietary diversity (WHO and UNICEF, 2007).

A chi^2 test was applied to test statistical significance between stunting and proposed factors. Only variables which were statistically associated with stunting (Ch^2 $p < 0.05$) were sent to the final binary logistic regression model which used to test the strength of the association and identify the independent determinant of stunting among children below five years old in Musanze District of Rwanda.

The analysis of anthropometric data was done on the basis of WHO Anthro then related to the nutrition determinants using SPSS. Data concerning food intake helped to obtain information about food quantity and frequency of consumption. Dietary intake of children was grouped and cut-off points were used in dietary diversity score. Descriptive analysis helped us to get percentages. The level of statistical significance was set at $p<0.05$.

3.3 Ethical consideration

3.3.1 Confidentiality

All personal information collected about the participants, their households and the children were treated as confidential (was not be given, disclosed to or discussed with anybody). Although the name of the child was required in the questionnaire, it did not serve any purpose other than to enable identification of duplicate responses and only the researcher had access to data storage and all relevant documents. The data must be accessible to supervisors, and to anybody else with written permission. The data access was safeguarded by an access password.

3.3.2 Informed consent

A thorough explanation about the purpose of the study was provided to participants. They were given enough time to ask questions and seek clarifications about the study. Once they had understood the study, they we requested to voluntarily participate. Upon their participation acceptance, they were asked to sign an informed consent form. The details about the informed consent are found in Appendix 4.

3.3.3 Ethical approval and research permit

Before any research activity was undertaken, ethical clearance certificate was obtained from Rwanda National Ethical Committee (RNEC), Approval for Scientific review from Rwanda National Health Research, Research Clearance Certificate from Directorate of Science, Technology and Research in the Ministry of Education, and permission was obtained from local leaders where the research was conducted.

CHAPTER 4 RESULTS

As presented in Table 2, the prevalence of stunting found was at 41.0% [40.5- 41.5], where males were 50.3%. It shows that 20.6% of children between 0 and 5 month were stunted, 42.5% of children between 6 and 23 months were stunted and 44.2% of children between 24 and 59 months were stunted.

Table 2: Prevalence of stunting of children below five years old

Background characteristics	N	Percent
Stunting status		
Stunted	15829	41.0
Not stunted	22791	59.0
Stunting by sex		
Females	5820	31.1
Males	10009	50.3
Stunting by age		
0-5 months	901	20.6
6-23 months	5511	42.5
24-59 months	9417	44.3

N= weighted number of children

The results on household heads characteristics summarized in Table 3 show that 5.6% of household heads are females and 94.4% are males. 7.2% live without partners while 92.8% live with partners either legally or illegally, 4.% of men are polygamous and 59.6%of household head did not complete or never got to primary school. 81.4% of households had more than 4 members per household, 36.5% of household reported that they were extremely poor and very poor as they are classified in wealth index scale of Rwanda.51.4% had no or little hunger, 43.1% had moderate hunger and 5.5% had severe hunger as calculated in household hunger score. Only 17% had a kitchen garden, 35.2% used industrial fertilizer, only 3.8% had at least training on modern agriculture, and 16.5% use enhanced seed for agriculture.

Table 3: Household heads characteristics

Background characteristics	N	Percent
Sex of household head		
Male	36471	94.4
Female	2149	5.6
Marital status of the head of household		
Lives with partner	35862	92.9
Lives without partner	2758	7.1
Polygamous husband		
Yes	1564	4.0
No	37055	96.0
Education of household head		
Informal education	8673	22.5
Formal education	29947	77.5
Household size		
Less than 4	7169	18.6
More than 4	31451	81.4
Wealth category		
Extremely poor	3651	9.5
Very poor	10415	27.0
Poor	19170	49.6
Resourceful poor	2553	6.6
Food rich	2665	6.9
Money rich	168	0.4
Household hunger scores		
Little or no hunger	19849	51.4
Moderate hunger	16663	43.1
Severe hunger	2109	5.5
Presence of kitchen garden		
Yes	6576	17.0
No	32044	83.0
Use of industrial fertilizer		
Yes	13608	35.2
No	25013	64.8
Agriculture training		
Yes	1480	3.8
No	36551	94.6
Do not know	589	1.5
Use of enhanced seeds		
Yes	6360	16.5
No	32259	83.5

N= weighted number of households

The results on mother characteristics described in Table 4 revealed that1.6% were less than 20 years old, 69.4% were between 20 and 34 years old and 29% were over 35 years old. Moreover, 8.4% live without partners, and 27.4% were informally educated, and 60.7% of mothers did not complete or never attended primary school. Furthermore, 63.6% depend on agriculture and only 20.5% completed four prenatal consultations during last pregnancy.

Table 4: Mother characteristics

Background characteristics	N	Percent
Age of the mother		
Less than 20 years old	628	1.6
Between 20 and 34 years old	26817	69.4
35 years old and plus	11176	29
Marital status of the mother		
Legal married	19687	51.0
Cohabitation	18933	49.0
Education of the mother		
Informal education	10569	27.4
Primary school drop out	14887	38.5
Primary school graduate	8574	22.2
Secondary school drop out	2643	6.8
Secondary graduate or higher	1947	5.0
Income generating activity		
No income	36339	94.1
Generating income	2282	5.9
Number of prenatal consultation during current or last pregnancy		
Four times	7903	20.5
Less than four	30717	79.5

N= weighted number of mothers

From Table 5 of the children characteristics, the results shows that11.3% were between 0 and 5 months old, 33.6% were between 6 and 23 months old while 55.1% were aged from 24 to 59 months old, 51.6% were males, 99.8% were vaccinated at birth, 22.7% had had diarrhea recently, 34.7% had had fever recently (within 2 weeks prior the study).

Table 5: Child characteristics

Background characteristics	N	Percent
Child age		
Aged 0-5 months	4376	11.3
Aged 6-23 months	12969	33.6
Aged 24-59 months	21274	55.1
Children sex		
Male	19916	51.6
Female	18704	48.4
Vaccination at birth		
Yes	38544	99.8
No	77	0.2
Diarrhoea (within the last 2 weeks)		
Yes	8774	22.7
No	29846	77.3
Fever (within the last 2 weeks)		
Yes	13419	34.7
No	25201	65.3

N= weighted number of children

The results in Table 6 show that 16.3% of children were not introduced to breastfeeding within one hour, 13.6% were not exclusively breastfed, 100.0% continued to breastfeed, and 46.6% were not yet introduced to solid, semi-solid or soft foods, while 83.5 had low dietary diversity. Indicators of feeding practices are calculated as recommended by WHO (WHO and UNICEF, 2007). 43.8% did not consume animal protein within one week preceding the study.

Table 6: Feeding practices of children below five years old

Background characteristics	N	Percent
Early introduction to breastfeeding		
0-1 hour after birth	14526	83.7
2 hours and more	2820	16.3
Total	17346	100.0
Exclusive breastfeeding		
Yes	3783	86.4
No	594	13.6
Total	4377	100.0
Continued breastfeeding at one year		
Yes	2704	100.0
Total	2704	100.0
Introduction of solid, semi-solid or soft foods		
Yes	1105	53.4
No	963	46.6
Total	2068	100.0
Minimum Dietary intake		
High dietary diversity	2134	16.5
Low dietary diversity	10835	83.5
Total	12969	100.0
Animal protein intake		
Yes	7289	56.2
No	5680	43.8
Total	12969	100.0

N = weighted number of children

Findings illustrated in Table 7 reveal that 15.6% of the households use water from lakes, ponds, rivers and 6.4% use water from unprotected sources. More than 90% use less than one hour for fetching water and 25.0% use unsafe water. Only 4.1% had hand washing facilities at their households, 12.3% had no latrines and 32.1% of them were doing open defecation around their households. 22.3% had solid waste disposal facility at household level but for 47.2% among them waste were lying around their households.

Table 7: Hygiene and sanitation of household of children below five years old

Background characteristics	N	Percent
Source of water used in household		
Safe water	28959	75.0
Unsafe water	9662	25.0
Treatment of drinking water		
No treatment	22778	59.0
Boiling	14677	38.0
Use of chemicals	1084	2.8
Filtering	81	0.2
Time for fetching water to source and		
Under 30mins	29886	77.4
Between 30min and 1hour	8105	21.0
Between 1hour and 1hour	579	1.5
Above 2hrs	50	0.1
Hand washing facility available		
Yes	1590	4.1
No	37030	95.9
Presence of latrine		
Yes	33860	87.7
No	4760	12.3
Open defecation		
Yes	10885	32.1
No	22975	67.9
Total	33860	100.0
Solid waste disposal facility		
Present	8604	22.3
Absent	30015	77.7
Solid waste spread around		
Present	4065	47.2
Absent	4539	52.8
Total	8604	100.0

N= weighted number of households

Table 8 aimed to determine the association between household heads characteristics and stunting of the children. Those Household heads characteristics are marital status of the head of household, polygamous husband, education of household head, household members, wealth categories, household hunger scores, presence of kitchen garden, use of industrial fertilizer, household agriculture training and use of enhanced seeds. A chi^2 test was used to test the association at significance level of 0.05. It has been shown that those household head characteristics were strongly associated with stunting of children below five years old in Musanze District. Marital status of the household head ($p<0.001$), polygamous husband ($p<0.001$), education of household head ($p<0.001$), number of household members ($p<0.01$), wealth categories ($p<0.001$), household severe hunger scores ($p<0.001$), absence of kitchen garden ($p<0.001$), nonuse of industrial fertilizer ($p<0.001$), absence of household agriculture training ($p<0.001$) and nonuse of enhanced seeds ($p<0.001$).

Table 8: Household heads characteristics and stunting of the children

	Stunted		Not stunted		Chi^2 P value (1)
	N	Percent	N	Percent	
Sex of household head					
Male	14755	40.5	21716	59.5	<0.001
Female	1074	50.0	1075	50.0	
Marital status of the head					
Lives with partner	14558	40.6	21304	59.4	<0.001
Lives without partner	1272	46.1	1487	53.9	
Polygamous husband					
Yes	972	62.1	592	37.9	<0.001
No	14857	40.1	22198	59.9	
Education of household					
Informal education	3928	45.3	4745	54.7	<0.001
Formal education	11901	39.7	18046	60.3	
Household members					
Less than 4	2815	39.3	4354	60.7	<0.001
More than 4	13014	41.4	18437	58.6	
Wealth category					
Extremely poor	1827	50.0	1824	50.0	
Very poor	3845	36.9	6570	63.1	
Poor	8291	43.2	10879	56.8	<0.001
Resourceful poor	912	35.7	1641	64.3	
Food rich	956	35.9	1709	64.1	
Money rich	0	0.0	168	100.0	
Household hunger scores					
Little or no hunger	8810	44.4	11039	55.6	<0.001
Moderate hunger	6125	36.8	10538	63.2	
Severe hunger	895	42.4	1214	57.6	
Presence of kitchen garden					
Yes	2266	34.5	4310	65.5	<0.001
No	13563	42.3	18481	57.7	
Use of industrial fertilizer					
Yes	5205	38.2	8403	61.8	<0.001
No	10625	42.5	14388	57.5	
Household agriculture training					
Yes	618	41.8	862	58.2	<0.001
No	15212	41.6	21339	58.4	
Do not know	0	0	589	100.0	
Use of enhanced seeds					
Yes	2272	35.7	4088	64.3	<0.001
No	13557	42.0	18702	58	

(1) Chi^2 P value significant at $p < 0.05$

N= weighted number of households

Table 9 targeted to determine the association between mother characteristics and stunting of the children. Those characteristics are marital status of the mother, main occupation of the mother, education of the mother, and number of prenatal consultations during last pregnancy. A chi^2 test was used to test the association at significance level of 0.05. It shows that those characteristics were strongly associated with stunting of children below five years old in Musanze District. Marital status of the mother (<0.001), main occupation of the mother (<0.001), education of the mother (<0.001), and number of prenatal consultations during last pregnancy (<0.001)

Table 9: Mother characteristics and stunting of the children

	Stunted		Not stunted		Chi^2P value (1)
	N	Percent	N	Percent	
Age of the mother					
Less than 20 years old	250	39.8	378	60.2	<0.001
Between 20 and 34 years old	10842	40.4	15975	59.6	
35 years old and plus	4738	42.4	6438	57.6	
Marital status of the mother					
Legally married	7571	38.5	12116	61.5	<0.001
Cohabitation	8259	43.6	10675	56.4	
Education of the mother					
Informal education	4919	46.5	5650	53.5	<0.001
Primary incomplete	5773	38.8	9114	61.2	
Primary complete	3282	38.3	5292	61.7	
Secondary incomplete	1574	59.6	1069	40.4	
Secondary complete and higher	281	14.4	1666	85.6	
Income generating activity					
No income	15092	41.5	21247	58.5	<0.001
Generating income	738	32.3	1544	67.7	
Number of prenatal consultation during current or last pregnancy					
Four times	2668	38.8	5235	66.2	<0.001
Less than four	13161	42.8	17556	57.2	

(1) Chi^2 P value significant at $p < 0.05$
N= weighted number of households

Table 10 shows the association between children characteristics and their stunting. Those characteristics are children age, children sex, vaccination at birth, vomiting recently and diarrhea and recent fever (last 2 weeks). A Chi2 test at significance level of 0.05, showed that children age is strongly associated with stunting ($p<0.001$), children sex is strongly associated with stunting ($p<0.001$), vaccination at birth is strongly associated with stunting ($p<0.001$), vomiting recently is strongly associated with stunting (<0.001), and diarrhea is strongly associated with stunting ($p<0.001$), but recent fever (last 2 weeks) was not. ($p=0.879$)

Table 10: Children characteristics and stunting

	Stunted		**Not stunted**		**Chi^{2}P value (1)**
	N	**Percen**	**N**	**Percent**	
Child age					
Aged 0-5 months	901	20.6	3475	79.4	
Aged 6-23 months	5511	42.5	7458	57.5	<0.001
Age 24-59 months	9417	44.3	11857	55.7	
Children sex					
Male	10009	31.1	9907	68.9	<0.001
Female	5820	50.3	12884	49.7	
Vaccination at birth					
Yes	15753	40.9	22791	59.1	<0.001
No	77	100.0	0	100.0	
Diarrhea (within the last 2 weeks)					
Yes	3773	43.0	5001	57.0	<0.001
No	12056	40.4	17790	50.6	
Fever (within the last 2 weeks)					
Yes	5507	41.0	7912	59.0	0.879
No	10322	41.0	14879	59.0	

(1) Chi^2 P value significant at $p < 0.05$
N= weighted number of children

Table 11 shows that there is a relationship between feeding patterns and stunting among children below five years old. Those factors are early introduction to breastfeeding, exclusive breastfeeding, continued breastfeeding at one year, introduction of solid, semi-solid or soft foods, minimum dietary diversity and consumption of animal proteins food, A chi2 test used to check the dependence shows that five out of the six predictors only 1 was not significantly associated with stunting (Early introduction to breastfeeding with P $\geq$ 0.451); continued breastfeeding at one year, was at 100%. The other 4 predictors are strongly significantly associated i.e. exclusive breastfeeding, Introduction of solid, semi-solid or soft foods, minimum dietary diversity and consumption of animal proteins food, with (P$\leq$0.001).

Table 11: Feeding practices of children and stunting

	Stunted		Not stunted		Chi^2P value (1)
	N	Percent	N	Percent	
Early introduction to breastfeeding					
0-1 hour after birth	5352	36.8	9174	63.2	0.451
2 hours and more	1060	37.6	1760	62.4	
Exclusive breastfeeding					
Yes	843	22.3	2940	77.7	<0.001
No	58	9.8	536	90.2	
Continued breastfeeding at one year					
Yes	1519	56.2	1185	43.8	-
Introduction of solid, semi-solid or soft foods					
Yes	564	51.0	541	49.0	<0.001
No	347	36.0	616	64.0	
Minimum Dietary intake					
Low dietary diversity	4363	39.5	6678	60.5	<0.001
High dietary diversity	1148	59.5	780	40.5	
Access to animal proteins food					
Yes	2598	35.6	4691	64.4	<0.001
No	2913	51.3	2767	48.7	

(1) Chi^2 P value significant at $p < 0.05$
N= weighted number of children

From the table 12, a chi^2 test shows that the following hygiene and sanitation characteristics are associated with stunting. Those are water used in household ($p \leq 0.021$), time for fetching water to source and back ($p \leq 0.001$), treatment of drinking water ($p \leq 0.001$), hand washing facility available ($p \leq 0.001$), presence of latrine ($p \leq 0.001$), no open defecation around ($p \leq 0.017$), waste disposal facility availability ($p \leq 0.001$), absence of waste lying around ($p \leq 0.001$).

Table 12: Hygiene and sanitation characteristics and stunting

	Stunted		Not stunted		Chi^2 P
	N	Percent	N	Percent	value (1)
Water used in household					
Safe water	11773	40.7	17186	59.3	<0.021
Unsafe water	4057	42.0	5605	58	
Time for fetching water to source and back					
Under 30mins	12335	41.3	17551	58.7	
Between ½-1hour	3271	40.4	4834	59.6	<0.001
Between 1-2hour	173	29.9	406	70.1	
Above 2hrs	50	100.0	0	0.0	
Treatment of drinking water					
No treatment	9798	43.0	12980	57.0	
Boiling	5605	38.3	9072	61.8	<0.001
Use of chemicals	345	31.8	739	68.2	
Filtering	81	100.0	0	0.0	
Hand washing facility available					
Yes	287	18.1	1303	81.9	<0.001
No	15542	42.0	21488	58.0	
Presence of latrine					
Yes	13752	40.6	20108	59.4	<0.001
No	2077	43.6	2683	56.4	
Open defecation around					
Present	4320	39.7	6565	60.3	0.017
Absent	9432	41.1	13543	58.8	
Waste disposal facility availability					
Yes	3135	36.4	5469	63.6	<0.001
No	12694	42.3	17321	57.7	
Solid waste lying around					
Present	2077	51.1	1988	48.9	<0.001
Absent	1058	23.3	3481	76.7	

(1) Chi^2 P value significant at $p < 0.05$ N= weighted number of households

The model controlling socio-demographic and economics characteristics of household is presented in Table 13. According to this table, household headed by female had an increased risks of having stunted children by 1.370 times higher compared to households headed by male (OR= 1.370, P≤ 0.001). However, marital status of the head of household was not associated with stunting (OR= 0.938, P≤ 0.316). Moreover, households where husbands were not polygamous and head of the household had formal education showed a protective effect from stunting (OR= 0.430, P≤ 0.001) and (OR= 0.814, P≤ 0.001) respectively while household where family member were more than four had risks 1.087 times higher to have stunted children compared to households where family member were less than four (OR= 1.087, P≤ 0.001).

As wealth increases, high wealth category shows protective effects from stunting compared to the lowest wealth category (OR= 0.478, P≤ 0.001), (OR= 0.913, P≤0.051 and (OR= 0.736, P≤ 0.001) respectively. In addition, Children of household with no kitchen garden are likely to be exposed to stunting 1.436 times more than those who have it (OR= 1.436, P≤ 0.001). Moreover, the fact of not using enhanced seeds by households and industrial fertilizer expose children to risk of getting stunted 1.383 times (OR= 1.383, P≤ 0.001) and 1.228 times compared to those who use them (OR= 1.228, P≤ 0.001) and severe hunger exposes children to stunting 1.204 times higher compared to those with little hunger (OR= 1.204, P≤ 0.001).

Table 13: Logistic regression model for household characteristics and stunting

	OR	95% C.I. for OR	P value
Sex of household head			
Male	1		
Female	1.370	[1.249-1.503]	<0.001
Marital status			
Living with partner	1		
Living without partner	0.938	[0.826-1.063]	0.316
Polygamous husband			
Yes	1		
No	0.430	[0.386-0.478]	<0.001
Education of household head			
Informal education	1		
Formal education	0.814	[0.771-0.858]	<0.001
Household size			
Less than 4	1		
More than 4	1.087	[1.029-1.148]	0.003
Wealth category			
Extremely poor	1		
Very poor	0.478	[0.430-0.532]	<0.001
Poor	0.913	[0.833-1.001]	0.051
Resourceful poor	0.736	[0.674-0.803]	<0.001
Presence of kitchen garden			
Yes	1		
No	1.436	[1.356-1.520]	<0.001
Use of enhanced seeds			
Yes	1		
No	1.383	[1.300-1.472]	<0.001
Use of industrial fertilizer			
Yes	1		
No	1.228	[1.167-1.291]	<0.001
Household hunger scores			
Little or no hunger	1		
Moderate hunger	0.747	[0.677-0.825]	<0.001
Severe hunger	1.204	[1.093-1.327]	<0.001

OR: Odd ration,

C.I. for OR: Confidence interval for Odd ratio

Significant at $p < 0.05$

From Table 14, it can be deduced that the age of the mother (more than 35) was not associated with stunting (OR= 0.983, P≤ 0.491) but those between 20 and 34 years old were more likely to have stunted children 2.581 times more than those under below 20 years old (OR=2.036; P≤ 0.001). Moreover, mothers live in cohabitation or singles were more likely to have stunted children 1.165 times compared to those who are legally married (OR= 1.165, P≤ 0.001).

Mothers who do not attend four prenatal consultations during their pregnancies risk to have stunted children 1.477 times higher than those who did it (OR= 1.477, P≤ 0.001). Furthermore, as the level of formal education increases, the less was the risk of having stunted children in comparison with informal education as follows: primary drop out (OR= 0.256, P≤ 0.001), primary graduate (OR= 0.356, P≤ 0.001), secondary drop out (OR= 0.357, P≤ 0.001), secondary graduate or higher (OR= 0.124, P≤ 0.001). In addition, mothers who had income generating activities were less likely to have stunted children compared to those who do not have income (OR= 1.477, P≤ 0.001).

Table 14: Logistic regression model for mother characteristics and stunting

	OR	95% C.I. for OR	P value
Age of the mother			
Less than 20 years old	1		
Between 20 and 34 years old	2.036	[1.703-2.433]	<0.001
35 years old and more	0.983	[0.938-1.031]	0.491
Marital status of the mother			
Legally married	1		
Cohabitation or single	1.165	[1.115-1.218]	<0.001
Education of the mother			
Informal education	1		
Primary drop out	0.256	[0.223-0.294]	<0.001
Primary graduate	0.356	[0.311-0.408]	<0.001
Secondary drop our	0.357	[0.311-0.410]	<0.001
Secondary graduate or higher	0.124	[0.107-0.145]	<0.001
Income generating activities			
No income	1		
Generating income	0.693	[0.627-0.765]	<0.001
Number of prenatal consultation during current or last pregnancy			
4 times	1		
Less than three times	1.477	[1.398-1.561]	<0.001

OR: Odd ratio

C.I. for OR: Confidence interval for Odd ratio

Significant at $p < 0.05$

Logistic regression model for children characteristics and stunting is summarized in Table 15 where female children have protective effect from stunting compared to male children (OR= 0.418, P≤ 0.001), while children aged 24-59 months were more likely to be stunted 1.239 times than those between 0 and 5 months old (OR= 1.239, P≤ 0.001) and children aged 6-23 months old were more likely to be stunted 3.248 times than those between 0 and 5 months old (OR= 3.248, P≤ 0.001). However, children who had recently diarrhea were less likely to be stunted compared to those who suffered from diarrhea (OR= 0.399, P≤ 0.001).

Table 15: Logistic regression model for children characteristics and stunting

	OR	95% C.I. for OR	Sig
Children sex			
Male	1		
Female	0.418	[0.416-0.452]	<0.001
Child age			
Aged 0-5 months	1		
Aged 6-23 months	3.258	[3.258-3.825]	<0.001
Age 24-59 months	1.239	[1.181-1.299]	<0.001
Diarrhea recently (Last 2 weeks)			
No	1		
Yes	0.399	[0.780-0.863]	<0.001

OR: Odd ratio

C.I. for OR: Confidence interval for Odd ratio

Significant at $p < 0.05$

From Table 16, Children who are not exclusively breastfed risk being stunted 2.319 times more than those who are exclusively breastfed (OR= 2.319, P≤ 0.001), while those who did not continually being breastfed have risked being stunted 1.507 times more compared to those who continued to breastfeed (OR= 1.507, P≤ 0.001). Moreover, children who have low dietary diversity are more exposed to stunting almost 2 times more than those who have access to high dietary diversity (OR=1.981,P≤0.001). In addition, children who do not have access to animal proteins have more risks for being stunted 1.195 times compared to those who do not have access (OR=1.195,P≤0.001).

Table 16: Logistic regression model for feeding practices and stunting

	OR	95% C.I. for OR	P value
Exclusive breastfeeding			
Yes	1		
No	2.319	[2.128-2.528]	<0.001
Continued breastfeeding at one year			
Yes	1		
No	1.507	[1.338-1.696]	<0.001
Minimum Dietary intake			
High dietary diversity	1		
Low dietary diversity	1.981	[1.785-2.198]	<0.001
Access to animal proteins			
Yes	1		
No	1.195	[1.115-1.281]	<0.001

OR: Odd ratio

C.I. for OR: Confidence interval for Odd ratio

Significant at $p < 0.05$

The model controlling hygiene and sanitation from Table 17, it can be deduced that household which use safe water were less likely to have stunted children (OR=0.597, P≤0.001 compared to those which use unsafe water. Thus, the treatment of drinking water offered more chances of having protected children than no treatment (OR=0.224, P≤0.001); for treatment with chemicals and (OR=0.318, P≤0.001) for treatment by boiling. Moreover, household with absence of hand washing facility in the house were likely to have stunted children almost 3 times compared to those with hand washing facility (OR=2.742, P≤0.001). In addition, household with no open defecation and those with no waste lying around were significantly protected from stunting (OR=0.810, P≤0.001), (OR=0.287, P≤0.001) respectively.

Table 17: Logistic regression model for hygiene and sanitation and stunting

	OR	95% C.I. for OR	P value
Water used in household			
Unsafe water	1		
Safe water	0.597	[0.536-0.664]	<0.001
Treatment of drinking water			
No treatment	1		
Boiling	0.318	[0.249-0.406]	<0.001
Use of chemicals	0.224	[0.175-0.287]	<0.001
Hand washing facility available			
Yes	1		
No	2.742	[2.13-3.526]	<0.001
Open defecation around			
Present	1		
Absent	0.810	[0.725-0.906]	<0.001
Solid waste lying around			
Present	1		
Absent	0.287	[0.257-0.321]	<0.001

OR: Odd ratio

C.I. for OR: Confidence interval for Odd ratio Significant at $p < 0.05$

C.I. for OR Confidence interval for Odd ratio

CHAPTER 5 DISCUSSION

This study was conducted to establish the factors associated with stunting and its prevalence among children below 5 years old and in Musanze District of Rwanda. The targeted number of households to be included in survey was 529 but only 482 could be included due to non-response from 47 households (8.9 %).

The prevalence of stunting among children below 5 year old in Musanze District was 41% which is surprisingly different from the study done in the same area in 2012 where the rate of stunting was higher than 61% (MINAGRI et WFP, 2012). This decline in the rate of stunting could be attributed to effort made by the government to reduce stunting rate by setting up strong nutrition related policies and programs. For example EDPRS 2, Health Sector Strategic Plan III, MINAGRI Strategic Plan for the Transformation of Agriculture Phase III (PSTA III), MINAGRI Nutrition Action Plan 2013-2018, Rwanda National Food and Nutrition Policy, Rwanda National Food and Nutrition Strategic Plan 2013-2018, and collaboration of different stakeholders to implement different programs such as PNBC, SUN, 1,000 Days campaign, WASH, CEBHPP and many nutrition campaigns which were done to improve nutrition status of children. A good progress has been made within 3 years but there is still a lot to be done.

However, the present study revealed that male children were more likely to be stunted than females. That could be supported by other studies which proved the same finding (Wamani et al, 2007). Females children and males are almost equally likely to be stunted globally, which is not the case in sub-Saharan Africa where stunting affects more boys than girls (Unicef, 2013). The fact that sub-Saharan area has a repetitive history of

poverty, and all forms of under development, this could be the reason behind of this elevated rate of stunting, and male children could be more defenseless to health problems than female of the same age groups and the results from Rwanda DHS 2015 revealed that stunting was at 38% in the whole country and found that it was increased with the age of children (NISR, 2015). From the results of the present study, as the age of child increases, it has been shown that the rate of stunting also increased. This could be due to many factors including poor care, poor weaning process, ignorance, poverty, childhood diseases which all can contribute to the stunting of a child.

The results from this study show that socio-demographic and economics characteristics (household headed by female, household sized more than four, lowest wealth categories,) increase the stunting risks. Adeladza (2010) suggested that could be attributed to the increase of poverty in female-headed families. Fikadu et al (2014) argued that children living in households of more than four family members have more risks to develop stunting than those living in household less than four family members in South Ethiopia. This might be due to the resource reduction which leads to the poverty and food insecurity in a household. A household with a big number of children, push the mother eventually to early weaning, then early introduction of soft, semi-solid food, and bottle feeding and finally to inappropriate complementary feeding, which have a large negative consequence on stunting (Fikadu et al., 2014).

The present study revealed that the rich households and moderately rich ones were less likely to have stunted children compared to the poorest. UNICEF reported the same tendency that children from the poorest households were two times more likely to be stunted in comparison with children from the richest households (Unicef, 2013).

The families which are not polygamous and household heads which are formally educated presented the protective effect from stunting. Another study argued that polygamous family settings presented risks factors for stunting while assessed the prevalence and risk factors associated with stunting among School children and Adolescents from Abeokuta in Southwest of Nigeria (Senbanjo et al, 2011). Low formal education of household head, absence of kitchen garden, the non-utilization of enhanced seeds and industrial fertilizer by households might increase poverty in family which is also positively associated with stunting. From this study severe hunger was found to expose children to stunting. The household hunger score also may indicate food security in household (Ballard et al., 2011).

The study conducted in South of Ethiopia found that there was no association between age of the mother and stunting (Fikadu et al., 2014). Surprisingly, the results from the present study shows that mothers aged between 20 and 34 were 2.036 times more likely to have stunted children than those less than 20 years old. This could be due to the reduced chance of having many children at lower age. The more the age increases, the more the number of children increases and the higher was the rate of stunting. Thus the fact of being in cohabitation increases the risks of having stunted children. This is in the same line with other research conducted in Lungwena, Mangochi, Southern Malawi (Gunda, 2007). Moreover, less than 4 antenatal visits have shown the risk of having stunted children which is in the same line as a study in the same area (Aguayo et al, 2015; Ozor & Omuemu, 2014).

The findings of the present study reveal that low education of the mother was strongly associated with stunting and the more the level of education of the mother increases, the more risks of having stunted children are few. This has been supported by similar findings (Senbanjo et al., 2011; NISR&MOH, 2010). Normally, as the mother increases the level of education, she does the same for her finance situation and to the total family income, bringing the family to food security then, scaling up nutritional status. Furthermore, mothers who are formally educated are more likely to make good choices targeting to improve life style nutrition and children's health. An educated mother is expected to facilitate all her children to go to school, by this means breach the chain of ignorance; she would adequately practice children breastfeeding, immunization, food supplementation, and family planning. Therefore, educating girls would be a useful step in the decline of the prevalence of stunting (Senbanjo et al., 2011).

The present study revealed that children, whose mothers had no income generating activities, were more likely to develop stunting than children whose mothers had. This is supported by the study conducted by Alelign et al (2015). This could be interpreted by mothers who are not working, the household income is more likely to be low, and the household is more likely to have poor nutrition, which has a large negative consequence on stunting.

Female children have shown more protective effect from being stunted than their male counterparts and this is supported by findings of other studies (Ramli et al., 2009). Findings from the present study show that there were more stunted children aged 24-59 months old than their younger counterpart. As a child's age increases, the process of weaning, the introduction to new types of feeding, make him or her to be more exposed

to the risks of stunting. These findings are supported by similar studies indicating that the males are more likely to be stunted than females (Ramli et al., 2009, Abubakar et al, 2012). The results from the present study show that children who had previously diarrhea were more likely to be protected from stunting than those who did not. This is in agreement with other research conducted in 2006 (Ricci et al., 2006) but also in contraction with Beckman et al, (2002) who found no significance between diarrhea and stunting. This association might not be caused by diarrhea as disease but to the treatment of diarrhea which help to decrease level of stunting.

The present study revealed that the risks of being stunted were more likely to be increased in children who are not exclusively breastfed. This agrees with another research conducted in Guinea Conakry which testify that human colostrum contained in early breast milk has the property of protection of diseases (Diallo, et al, 2009) while those who are discontinued of being breastfed have more risk of being stunted 1.507 times compared to those who continued being breastfed. Nevertheless, discontinuation of breastfeeding means introduction to foods, which are sometimes not well diversified. (The present study found that 78.4% of children had low dietary diversity), consequently, there is a high reliance on liquids, juices, and black tea which might decrease desire for solid foods and also cause loose stools. Some studies in the U.S.A. have related extreme juice intake with stunting, obesity, and failure of children to grow vigorously (Dennison et al, 1997).

Children who has low dietary diversity were more likely to be stunted almost 2 times more than those who have access high dietary diversity and those who had access to animal proteins food have less risks for being stunted compared to those who do not have

access to them. The findings of the present study are in the same line with survey conducted in Nepal (Ruwali, 2011, Marriott et al, 2012).

Households which use safe water had less risks of having stunted children than those who use unsafe water. In addition, household with no open defecation, no waste lying around and no hand washing facility at household level showed significant protection from stunting while households with absence of hand washing facility at household level were more likely to have stunted children compared to those with hand washing facility. This is confirming what has been found by others (Babatunde et al., 2011).

Poor hygiene has been linked also to low maternal education which is strongly associated with the risk of stunting (Armar et al., 2000; Ruel-Bergeron et al., 2015). Therefore, use of safe water plays an important role in prevention of the spread of water-borne diseases which have a negative impact on the health and nutrition of children.

The present study has proved that among households with latrines as well as open defecation, households with solid waste disposal facilities as well as presence of waste lying around have a good number of stunted children and the association was strongly significant. To have sanitation infrastructures is different from practicing hygiene. Many people tend to have infrastructures but they need to know how and why to use them and to be familiar with them. The hygiene practice must be a habit.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The prevalence of stunting was 41% whereby males were 50.3% and females 31.1%. 19.6% were children aged 0-5 months, 42.5% were children aged 6-23 months and 44.3% were children aged 23 to 59 months old.

Socio-demographics and economics characteristics independent predictors of stunting are female headed household, polygamous husbands, low education of household head as well as the mother, household size (large), low wealth index, absence of kitchen garden, nonuse of enhanced seeds, nonuse of industrial fertilizer, severe household hunger scores, mother cohabitating, low prenatal consultation rate, absence of income generating activity from mothers, child sex (male), and child age.

Feeding practices independently associated with stunting are nonexclusive breastfeeding, discontinued breastfeeding, low dietary intake, and inaccessibility to food containing animal proteins.

Children suffered from Diarrhoea have shown a protective effect from stunting; fever and vomiting were not independently associated with stunting.

Hygiene and sanitation independent predictors of stunting are use of unsafe water in household, no treatment of drinking water, absence of hand washing facility at household, open defecation around, waste lying around in a household.

Recommendations

From this study, it is clear that poor socio-economic characteristics, feeding practices, hygiene and sanitation can influence child nutritional status. However, stakeholder in scaling up nutrition should focus on identified factors to reduce the rate of stunting. Mothers and caretakers should be educated and economically reinforced. Hygiene and sanitation must be emphasized on. Thus, the government and its stakeholders should emphasize on both sustainability and ownership of sanitation infrastructures, as well acknowledge, attitudes and practices of the population regarding to scaling up nutrition.

1. The population should be involved in nutrition and health improvement programs to ensure ownership and sustainability.
2. Polygamy and cohabitation should be discouraged
3. Family planning and antenatal consultation should be encouraged and emphasized on.
4. The population should be educated about nutrition, hygiene and sanitation, family planning, and improvement of agriculture.
5. Nutrition and health improvement programs should emphasize on community and individual behavioral change.
6. The women empowerment should start with education.
7. WASH (water, hygiene and sanitation) should focus more on behavior change to complement and to support sanitary infrastructures)
8. Sanitary inspection at household level should be multidisciplinary and emphasize and focus on education and behavior change.

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Appendix 1: Information sheet

My name is HABIMANA Jean de Dieu. I am conducting a study on "**Factors associated with stunting and its prevalence among children below 5 years old in Musanze district of Rwanda**" The study is in partial fulfillment of a Master's of Science in Applied Human nutrition, from University of Nairobi. The objective is to generate ahierarchy of contributing factors to the malnutrition of children below 5 years old. Knowing these factors was help in development of high effective strategies to combat malnutrition in Rwanda, especially where stunting is highly prevailing. The Country will produce healthy people, this will reduce the cost of interventions that focus on nutrition and it was accelerate the progress to achieve the MDGs at the end increase the Economy of the Country. Only, randomly selected households are invited to participate. I therefore really value your participation. You are kindly requested to participate in the abovementioned study.

The questionnaire will take approximately 45 to 60 minutes to complete. Please be assured that all your responses will be treated confidentially and anonymity of your responses in the final report is guaranteed. Also note that participation is voluntary and that you may withdraw your permission to participate at any stage without any negative consequences.

Although the name of your child is required in the questionnaire, it does not serve any purpose other than to enable me to identify duplicate responses and to follow up on interesting responses by means of interviews, should you provide permission for the latter. I assure you that all responses received was only be used for scientific purposes within the framework of this survey. The results of the survey may be published in a scientific journal.

For any enquire about any aspect of this project, please email me at jdhabimana@khi.ac.rw or kajado7@yahoo.fr. Alternatively you can phone me at +250 788446024.

Thank you for participating in this survey.

Yours Sincerely.

HABIMANA Jean de Dieu

Appendix 2: Consent form

TITLE OF THE STUDY: **FACTORS ASSOCIATED WITH STUNTING AND ITS PREVALENCE AMONG CHILDREN BELOW 5 YEARS OLD IN MUSANZE DISTRICT OF RWANDA**

I, _____

agree to participate in the study "**Factors associated with stunting and its prevalence among children below 5 years old in Musanze district of Rwanda**". I am aware that participation in the study is voluntarily and I will not be paid for the participation. In addition, all information provided will be treated with confidentiality and that my anonymity will be maintained. I am aware that the results of this study may be published but I will not be identified as an individual. I reserve the right to withdraw from the study at any time if I so wish.

_____ …./…../….

Signature of participant Date

Signature

HABIMANA Jean de Dieu.
Researcher
Kigali, Rwanda.

Appendix 3: Data collection tool

1. To be completed by Enumerator *Please complete before the Interview*					
Section 1e: Identification					
001	Date: |__|__|/|__|__|/201… Day months				
002	Cell name:				
003	Village name:				
004	Household Number:				
005	**Do you agree to be interviewed**	1= yes	If no end here	1= no	Yes (Please make sure head of household agrees to the being interviewed then continue)
Section 2: social demographics and economics characteristics: Read - "**I would now like to ask you a few questions on the composition of your household**"					
006	The name of child under five	……..			
007	Birth date |__|__|/|__|__|/201…	Age in months |__|__|			
008	Sex of the child |__|	M=1 , F=2			
009	What is the birth order of the index child |__|	Insert the number			
010	Relation with the caregiver |__|	Parents =1, grandparents =2, adoptive parents=3, relative =4, no relation=4 other=5 (precise)			
011	What is the number of months between the index child and the child before and after?	|__|__|from the previous |__|__|to the following			
012	How many children of this family?	|__|__|			
013	How many children below five years old?	|__|__|			
014	What is marital status of the caregiver |__|	1=married, 2=partner, 3=divorced/separated, 4= Widow or widower, 5=never married			
015	Monogamous |__| Yes=1 No=2	Polygamous |__| Yes=1 No=2			
016	Education of head of household |__|	**1** = No School; **2** = Some Primary; **3** = Completed Primary; **4**= some secondary; **5** = Vocational School; **6** = Completed Secondary; **7** = Some / Completed University or College			
017	Education of the mother |__|	**1** = No School; **2** = Some Primary; **3** = Completed Primary; **4**= some secondary; **5** = Vocational School; **6** = Completed Secondary; **7** = Some / Completed University or College			
018	Main occupation of the head of household |__|	1= Salaried / Pension 2= business 3= Artisan 4=Agriculture 5=Daily job 6=Other			
019	Main occupation of the mother |__|	1= Salaried / Pension 2= business 3= Artisan 4=Agriculture 5=Daily job 6=Other			
020	What is the wealth category (ubudehe) of your household? |__|	1= Extremely poor, 2= Very poor, 3=Poor, 4= resourceful poor, 5=Food rich, 6=Money reach			
021	Does the household have access to agricultural land? |__|	1=Yes2=No			

022	Does your household own vegetable garden?	|__|	1=Yes2=No				
023	Does the household own any livestock? Indicate if it produce any animal food product	|__|	1=Yes 2=No	**if no→ skip to 024**			
a	Cow	|__|	f	Guinea pig	|__|		
b	Goat	|__|	g	Turkey	|__|		
c	Lamb	|__|	h	Pigeon	|__|		
d	Pork	|__|	i	Rabbit	|__|		
e	Chicken	|__|	j	Others (Specify)	|__|		
024	Did you ever experience any lack of food to eat of any kind in your house because of lack of resources to get food in last 4 weeks?	|__|	1=Yes 2= No	If yes how many times	|__|		
025	In the last 4 weeks, did you or any household member go to sleep at night hungry because there was not enough food?	|__|	1=Yes 2= No	If yes how many times	|__|		
026	In the last 4 weeks, did you or any household member pass day hungry because there was not enough food?	|__|	1=Yes 2= No	If yes how many times	|__|		

Section 4: The status of household hygiene and sanitation among the households of the children below five years old

Presence and hygiene status of:

027	**Latrines:**		
A	Clean	|__|	1=Yes 2= No
B	Covered	|__|	1=Yes 2= No
C	No insect around	|__|	1=Yes 2= No
D	Not full	|__|	1=Yes 2= No
E	In use	|__|	1=Yes 2= No
F	No bad smell	|__|	1=Yes 2= No
G	No open defecation around	|__|	1=Yes 2= No
028	**Waste disposal**		
A	Presence of Waste disposal facility	|__|	1=Yes 2= No
B	Not full	|__|	1=Yes 2= No
C	In use	|__|	1=Yes 2= No
D	No wastes around	|__|	1=Yes 2= No
Safe water:			
029	Source of water used: where kind of water do you use?		
A	Rain	|__|	1=Yes 2= No
B	Tape	|__|	1=Yes 2= No
C	Borehole	|__|	1=Yes 2= No
D	River	|__|	1=Yes 2= No
E	Lake	|__|	1=Yes 2= No
f	Other source	|__|	1=Yes 2= No

030	How long time do you have to go to collect water?	|__|	Less than 30 min, between 30-60 min, between 1-2 hours, more than 2 hours

Personal Hygiene of Child caregivers and food preparers with appropriate hand washing behavior			
031	Hand washing facilities	|__|	1=Yes 2= No
032	Water	|__|	1=Yes 2= No
033	Soap	|__|	1=Yes 2= No
034	Knowledge of 5 critical time for Hand washing:		
	○ Before food preparation and eating	|__|	1=Yes 2= No
	○ Before feeding children	|__|	1=Yes 2= No
	○ After sneezing and coughing	|__|	1=Yes 2= No
	○ After cleaning babies' bottoms	|__|	1=Yes 2= No
	○ After visiting toilet	|__|	1=Yes 2= No

History of diseases associated with poor hygiene (for children under 5)			
035	Has [NAME] been ill in the last 2weeks?	|__|	1=Yes 2= No
	○ Diarrhea	|__|	1=Yes 2= No
	○ Respiratory infection	|__|	1=Yes 2= No
	○ Intestinal worms	|__|	1=Yes 2= No
	○ Typhoid fever	|__|	1=Yes 2= No
	○ Vomiting	|__|	1=Yes 2= No
	○ Other	|__|	1=Yes 2= No
036	Has [NAME] received vaccine according to age? (verify on growth monitoring child card)	|_	1=Yes 2= No

At birth (Polio Tuberculosis)	At one month and half (Polio, Pentavalent, rotavirus)	At two months and half (Polio, Pentavalent, rotavirus)	At three month and half (Polio, Pentavalent, rotavirus)	At nine months (Measles and
|__| |__|	|__|	|__|	|__|	|__|

Section 5: Nutrition status (Anthropometry) of the index below five years old children				
		1st Measurement	2nd measurement	Average
037	Child **height/length** (in centimeters, with one decimal place) Child measurement < 85cm < 24 months, must be done lying	|__|__|__|.|__|	|__|__|__|.|__|	|__|__|__|.|__|
038	**Child weight***(enter weight in kilograms, with one decimal place)*	|__|__|.|__|	|__|__|.|__|	|__|__|.|__|
039	**Child MUAC** (in centimeters)	|__|__|__|.|__|	|__|__|__|.|__|	|__|__|__|.|__|
040	Does the child have bilateral pitting edema?	|__|	1=Yes 2= No	

Section 7: To determine the food consumption practices of the children below five years old			
041	Has [NAME] ever been breastfed after birth?	|__|	1 = Yes **2= No→ skip to 066**
042	How long after birth was [NAME] first put to the breast?	|__|	1= 30 min after birth 2=within hours from birth 3 = within days from birth 4= never 5= Don't know

043	In the first six months after delivery, was [NAME] given anything to drink or other food other than breast milk?	|__|	1=Yes 2= No
044	Is [NAME] still being breastfed?	|__|	1=Yes 2= No
045	If not which time did you stopped to breastfeed?	|__|	Fill in the number of months
046	If not, How did you stop breast feeding	|__|	1 = At once 2 = Reducing the number of breast feeding per day 3 = only night or day breast
047	At the moment, does your baby get any drinks or food other than breast milk?	|__|	1=Yes 2= No
048	How old was your baby when you gave this drink or food for the first time?	|__|	Record the number of months
049	What was the reason that triggered you to offer your baby that drink or food?	|__|	1 = Inadequate breast milk 2 = Inadequate weight gain 3 = Work 4 = Other: _____
050	What was the first drink or food that your baby ate?	1---------- 2----------	Rec ord
051	Is your baby given food on her/his demand per schedule or does it depends on the mother/caretaker	|__|	1 = Child's demand, 2 = Schedule, 3 = caretaker

052 Could you please tell me how many days in the **last 7 days** you child has eaten the following foods and what the source was *(use codes below, write 0 for items not eaten over the last 7 days and if several sources, write main one*

	Category	**Food Item**	**Days /week**	**Main *Food Source***
A	Starches	Maize/Maize meal (*e.g. Ugali, posho*)	|__|	|__|
b		Sorghum (Polidge)	|__|	|__|
c		Sorghum (local beer, ubushera...)	|__|	|__|
d		*Rice,*	|__|	|__|
e		*Wheat*	|__|	|__|
f		Other cereals	|__|	|__|
G		Cassava (ugali or not)	|__|	|__|
h		White sweet Potato	|__|	|__|
i		Orange sweet Potato	|__|	|__|
j		Irish Potatoes	|__|	|__|
k		Other White Roots and tubers	|__|	|__|
l		Mandazi / Chapatti / Bread	|__|	|__|
m		Cooking banana	|__|	|__|
n		Banana (Sweet)	|__|	|__|
o	Pulses	Beans, Peas and other pulses	|__|	|__|
	Vegetables	Carrot	|__|	|__|
P		Dark green leafy vegetables	|__|	|__|
q		Pumpkin, squash and other orange vegetables	|__|	|__|
R		Cabbage	|__|	|__|
S		Other Vegetables	|__|	|__|
t	Nuts and oil	Ground nuts and seeds	|__|	|__|

u	seeds	Soybean	|__|	|__|
v	Fruits	Avocadoes	|__|	|__|
w		Pineapple	|__|	|__|
x		Apple	|__|	|__|
Y	Orange coloured fruits	Papaya	|__|	|__|
Z		Mangoes	|__|	|__|
aa		Orange	|__|	|__|
ab		Other Fresh fruits	|__|	|__|
ac	Animal origin	Fish	|__|	|__|
ad		Organ Meat (liver kidney, heart, intestines, blood based food.)	|__|	|__|
ae		Flesh meat (beef, goat, pork, lamb rabbit, chicken and other poultry etc…)	|__|	|__|
af		Eggs	|__|	|__|
ag		Milk and milk products	|__|	|__|
ai	Fat and oil	Oil, fat, butter, ghee (including palm oil), margarine	|__|	|__|
aj	Condiments	Condiments (salt, pepper, other spices, fish powder, or other items used to give flavor to the food: pilipili, onions….)	|__|	|__|
ak		Sugar and sweets	|__|	|__|
al		Other to specify	|__|	|__|

Food frequency 1= once 2= twice	3= three times 4= 4 times 5= 5 times	6= 6 times 7=7 times 100=Occasionally	99=Never 50= twice a day

Appendix 4: Ubusobanuro (Kinyarwanda Version of appendix 1)

Nitwa HABIMANA Jean de Dieu. Ndi gukora ubushakashatsi "**igipimo cy'ukugwingira mu bana bari munsi y'imyaka itanu n'impamvu zishobora kuba zibitera mu Murenge wa Kinigi, Akarere ka Musanze mu Rwanda**" ubushakashatsi bugamije kumfasha gutsindira impamyabumenyi y'icyciro cya gatatu cya Kaminuza mu bijyanye n'imirire y'abantu muri Kaminuza ya Nairobi.Ikigenderewe ni ukugenekereza igipimo cy'imirire mibi mu bana bari munsi y'imyaka itanu n'uburemere bw'impamvu zishobora kuba zibitera. Kumenya izo mpamvu, bizatuma habaho gufata ingamba zihamye mu kurwanya indwara ziterwa n'imirire mibi, cyane cyane aho igipimo cyo kugwingira kiri hejuru. Igihugu kizunguka abantu bazira umuze, hagabanuke amafaranga yatangwaga ku burwayi, kandi amajyambere yiyongere tubashe kugera ku ntego z'ikinyagihumbi. Ingo zatoranyijwe nizo zonyine zisubisa ibibazo.Icyo musabwa ni ukugira uruhare musubiza ibibazo biri ku rupapuro rwabugenewe. Twishimiye uruhare rwanyu mu kudufasha gusubiza ibi bibazo.

Gusubizabiratwara hagati y'iminota 45 na 60. Ndabizeza ko ibibazo byose bizabikanwa ibanga rikomeye kandi izina ryanyu ntaho rizagaragara. Ikindi kandi, gusubiza ibi bibazo ni ubushake bwanyu kandi mushobora guhagarika gusubiza igihe cyose mubangamiwe cyangwa mutishimiye ibibazwa. Nubwo izina ry'umwana wanyu rigaragara mu bibazo, ntacyo rizahungabanya ku ibanga ry'ibyo mwasubije. Rizadufasha kumenya niba tutanditse ibisubizo by'umuntu umwe kenshi no kugenzura neza uko kubaza ibibazo bigenda. Ndabizeza ko ibisubizo byanyu bizakoreshwa ku mpamvu z'ubu bushakashatsi gusa kandi ibizabuvamo bizatangazwa mu kinyamakuru cy'ubumenyi.

Ku kibazo icyo ari cyo cyose mwagira cyangwa se ubundi busobanuro mwabaza kuri izi aderesi
jdhabimana@khi.ac.rw cyangwa kajado7@yahoo.fr.
cyangwa kuri iyi nimero ya telephone +250 788446024.

Murakoze ku bushake bwanyu bwiza bwo kudufasha.

HABIMANA Jean de Dieu

Appendix 5: Amasezerano y'uwemeye kugira uruhare mu bushakashatsi (Kinyarwanda Version of appendix 2)

Izina ry'ubushakashatsi: **igipimo cy'ukugwingira mu bana bari munsi y'imyaka itanu n'impamvu zishobora kuba zibitera mu Murenge wa Kinigi, Akarere ka Musanze mu Rwanda.**

Njyewe, _____

Niyemeje kugira uruhare mu bushakashatsi "**igipimo cy'ukugwingira mu bana bari munsi y'imyaka itanu n'impamvu zishobora kuba zibitera mu Murenge wa Kinigi, Akarere ka Musanze mu Rwanda"**

Nsobanukiwe ko kugira uruhare ari ubushake bwanjye kandi ko nta gihembo ntegereje kandi ko ibisubizo ntanga bizabikanwa ibanga rikomeye. Nsobanukiwe kandi ko ibizava muri ubu bushakashatsi bizatangazwa mu kinyamakuru cy'ubumenyi kandi izina ryanjye ntirizatangazwa. Ikindi nsobanukiwe ko ndamutse mbangamiwe nahagarika ibibazo.

_____ …./…../….

Umukono Itariki

Umukono

HABIMANA Jean de Dieu.
Umushakashatsi

Appendix 6: Ibibazo bigenewe ingo z'abana batarengeje imyaka itanu (Kinyarwanda Version of appendix 3)

1. ahuzuzawa n'ubaza*Huzuze mbere y'uko kubaza bitangira*						
Igice cya mbere: Irangamimerere ry'urugo						
001	Itariki:|__|__|/|__|__|/ 201…					
002	Izina ry'Akagari:					
003	Izina ry'Umudugudu:					
004	Inimero y'urugo:					
005	Ese muremera kubazwa	1=yego	Niba ari oya rekera aho	1= oya	Niba ari yego musabe agusinyire ku rupapuro rwabugenewe	
Igice cya kabiri: imiterere n'imibereho y'urugosoma "nifuza kubabaza ibibazo ku yerekeranye n'urugo rwanyu						
006	Izina ry'umwana uri munsi y'imyaka itanu	……				
007	Itariki yavutseho	|__|__|/|__|__|/201…	Amezi yujuje	|__|__|		
008	Igitsina cye	|__|	Gabo=1 , Gore=2			
009	Ese uyu mwana avuka ari uwa kangahe?	|__|	Uzuzamo umubare			
010	Umwana apfana iki n'umurera?	|__|	Umwana we =1, umwuzukuru (za) =2, umwana wakiriwe mu muryango=3, uwo mu muryango =4, nta sano=4 ikindir=5 (kivuge)			
011	Harimo igihe kingana n'amezi angahe hagati y'umwana n'abo bakurikirana?	|__|__|ku wo akurikira |__|__| k'umukurikira				
012	Uru rugo rufite abana bangahe?	|__|__|				
013	Uru rugo rufite abana bangahe bari munsi y'imyaka itanu?	|__|__|				
014	Irangamimerere ry'urera umwana	|__|	1=yarashyingiwe (mu mategeko)2=babana batarashyingiwe)3=yatanye n'uwo bashakanye, 4=yarapfakaye, 5=ntiyigeze ashyingirwa			
015	Umugabo afite umugore umwe	|__|	Yego=1 Oya=0	Umugabo wawe yaba afite undi mugore?	|__|	Yego=1 Oya=0
016	Amashuri umukuru w'urugo yize	|__|	1=ntayo, 2=ntiyarangije abanza, 3=yarangije abanza, 4= ay'imyuga 5=ntiyarangije ayisumbuye, 6=yarangije ayisumbuye 7=amashuri makuru			
017	Amashuri umurera yize	|__|	1=ntayo, 2=ntiyarangije abanza, 3=yarangije abanza, 4= ay'imyuga 5=ntiyarangije ayisumbuye, 6=yarangije ayisumbuye 7=amashuri makuru			
018	Icyo nyirurugo akora	|__|	1= umunyamushara/ikiruhuko cy'izabukuru 2= business (ubushabitsi) 3= ubugeni/imyuga 4=ubuhinzi/ubworozi 5=nyakabyizi 6=ikindi (sobanura)			
019	Icyo nyina akora	|__|	1= umunyamushara/ikiruhuko cy'izabukuru 2= business (ubushabitsi) 3= ubugeni/imyuga 4=ubuhinzi/ubworozi 5=nyakabyizi 6=ikindi (sobanura)			
020	Muri mu kihe cyiciro cy'ubudehe?	|__|	1=Umutindi nyakujya, 2=Umutindi, 3=Umukene, 4=Umukene wifashije, 5=Umukire, 6=Umukungu			
021	Ese mufite ahantu muhinga	|__|	1=Yego 0=Oya			

022	Ese mufite akarima k'imboga?	|__|	1=Yego0=oya				
023	Ese hari itungo mworoye? (Uzuzamo umubare w'amatungo ahari)	|__|	1=Yego 0=oya	**Niba ari oya→jya kuri 024**			
a	Inka	|__|	f	Cobaye	|__|		
b	Ihene	|__|	g	Dendo	|__|		
c	Intama	|__|	h	Inuma	|__|		
d	Ingurube	|__|	i	Inkwavu	|__|		
e	Inkoko, imbata	|__|	j	Ibindi (bivuge)	|__|		
024	Mu byumweru bine bishize (iminsi 30), byigeze biba ko uru rugo rubura ibyo kurya na mba bitewe no kubura ubushobozi?	|__|	1=Yego 0=Oya	Niba ari yego byabaye kangahe?	|__|		
025	Mu byumweru bine bishize (iminsi 30), wowe cg undi muntu muri uru rugo yigeze ajya kuryama ashonje kubera ko ibiryo byari bike?	|__|	1=Yego 0=Oya	Niba ari yego byabaye kangahe?	|__|		
026	Mu byumweru bine bishize (iminsi 30), wowe cg undi muntu muri uru rugo yigeze abwirirwa kubera ko ibiryo byari bike?	|__|	1=Yego 0=Oya	Niba ari yego byabaye kangahe?	|__|		
Igice cya4: isuku n'isukura mu rugo							
027	**umusarani:**						
a	Urasukuye?	|__|	1=Yego 0=Oya				
b	Urapfundikiye?	|__|	1=Yego 0=Oya				
c	Nta dusimba duhari (isazi, inyenzi, ibitaganguriwa)	|__|	1=Yego 0=Oya				
d	Ntabwo uruzura	|__|	1=Yego 0=Oya				
e	Urakoreshwa	|__|	1=Yego 0=Oya				
f	Nta mpumuro mbi ihari	|__|	1=Yego 0=Oya				
g	Nta kwituma ku ruhande	|__|	1=Yego 0=Oya				
028	**Uko bagenza imyanda**						
a	Hari ikimoteri (aho kumena imyanda)	|__|	1=Yego				
b	Ntabwo cyuzuye	|__|	1=Yego				
c	Kirakoreshwa	|__|	1=Yego				
d	Nta bishingwe biri ahazengurutse	|__|	1=Yego				
Amazi meza:							
029	Amazi mukoresha hano murugo aturukahe?						
a	Imvura	|__|	1=Yego				
b	Robine	|__|	1=Yego				
c	Isoko	|__|	1=Yego				
d	Umugezi	|__|	1=Yego				
e	Ikiyaga	|__|	1=Yego				
f	Ahandi (havuge)	|__|	1=Yego				
030	Bibatwara igihe kingana iki kujya kuvoma	|__|	Munsi y'iminota 30,hagati y'iminota 30-60, hagati y'isaha 1-2, hejuru y'amasaha 2				

Isuku y'abarera umwana n'abatunganya ibiribwa			
031	Hari aho gukarabira intoki	|__|	1=Yego 0=Oya
032	Hari amazi	|__|	1=Yego 0=Oya
033	Hari isabune	|__|	1=Yego 0=Oya
034	Uzi ibihe bitanu by'ingenzi byo gukaraba intoki		
	○ Mbere yo hutegura ibiribwa no kurya	|__|	1=Yego 0=Oya
	○ Mbere yo kugaburira umwana	|__|	1=Yego 0=Oya
	○ Nyuma yo gupfuna no gukorora	|__|	1=Yego 0=Oya
	○ Nyuma yo guhanagura umwana umaze	|__|	1=Yego 0=Oya
	○ Nyuma yo kwituma	|__|	1=Yego 0=Oya

Ubuzima bw'umwana			
035	Umwana yaba aheruka kurwara muri ibi byumweru 4 bishize?	|__|	1=Yes 2= Oya
	○ Diyare	|__|	1=Yego 0=Oya
	○ Umusonga, inkorora	|__|	1=Yego 0=Oya
	○ Inzoka zo mu nda	|__|	1=Yego 0=Oya
	○ Tifoyide (Typhoid fever)	|__|	1=Yego 0=Oya
	○ Kuruka	|__|	1=Yego 0=Oya
	○ Izindi (zivuge)….	|__|	1=Yego 0=Oya
036	Umwana yarakingiwe inkingo zose ukurikije amezi agejejeho? (reba igisubizo ku ikarita y'ikingira)	|__|	1=Yego 0=Oya

Akivuka (igituntu n'imbasa)		**Afite ukwezi n'igice** (Imbasa,kokorishi, agakwega,akaniga, Hib, hepatite B, pinemokoke, impiswi)	**Afite amezi abiri n'igice** (Imbasa,kokorishi, agakwega,akaniga, Hib, hepatite B, pinemokoke, impiswi)	**Afite amezi atatu n'igice** (Imbasa,kokorishi, agakwega,akaniga, Hib, hepatite B, pinemokoke,	**Afite amezi 9** (iseru na rubeole
|__|	|__|	|__|	|__|	|__|	|__|

Igice cya 5: ibipimo byerekana imirire y'umwana				
		Igipimo cya mbere	Igipimo cya kabiri	impuzandengo
037	Uburebure bw'umwana (umubare umwe nyuma y'akitso. (munsi yamezi 24 umwana apimwa aryamye)	|__|__|__|.|__|	|__|__|__|.|__|	|__|__|__|.|__|
038	Uburemere bw'umwana (umubare umwe inyuma y'akitso)	|__|__|.|__|	|__|__|.|__|	|__|__|.|__|
039	Umuzenguruko w'ikizigira cy'akaboko (umubare umwe inyuma y'akitso)	|__|__|__|.|__|	|__|__|__|.|__|	|__|__|__|.|__|
040	Reba niba umwana abyimbaganye	|__|	1=Yego 0=Oya	

Igice cya 5: ibijyanye nibyo umwana arya ndetse n'uko abirya.			
041	Uyu mwana yigeze yonka	|__|	1 = Yego **0=Oya→ jya kuri 066**
042	Yatangiye konka amaze igihe kingana iki avutse?	|__|	1= iminota 30 2=mu isaha imwe 3 = nyuma y'iminsi 4= ntiyigeze yonka 5= simbizi

043	Ese hari ikindi yigeze ahabwa cyunganira amasherekamu mezi atandatu ya mbere?	|__|	1=Yego 0=Oya
044	Ese aracyonka?	|__|	1=Yego 0=Oya
045	Niba ari oya yabihagaritse ku mezi angahe?	|__|	Uzuzamo umubare w'amezi
046	Niba ari oya yabihagaritse gute?	|__|	1 = rimwe kuri rimwe 2 = nagabanyije incuro yonka ku munsi 3 = yatangiye yonka ku manywa gusa cg nijoro
047	At the moment, does your baby get any drinks or food other than breast milk?	|__|	1=Yego 0=Oya
048	Watangiye kumuha imfashabere ku mezi angahe	|__|	Uzuzamo umubare w'amezi
049	Ese ni iyihe mpamvu yatumye umuha imfashabere	|__|	1 = amashereka adahagije 2 = nabonaga afite ibiro bike 3 = akazi 4 = ikindi: _____
050	Wamutangije ku kihe kinyobwa cg ikiribwa?	1---------- 2----------	Uzuzamo umubare w'amezi
051	Ukurikiza iki kugira ngo umenye igihe uhera umwana ibyo kurya?	|__|	1 = iyo abisabye 2 = mfite gahunda ngenderaho 3 = iyo mbonye akanya
052	Nifuzaga ko mumbwira iminsi mwaba mwarariye ibiribwa bikurikira ndetse naho byavuye muri iyi minsi irindwi ishize. Uzuzamo umubare uhwanye n'iminsi.		

	Icyiciro	**Ibiribwa**	**Iminsi/Icyumweru**	**Aho bituruka**
a	Ibitera imbaraga (Ibinyasukari)	Ibinyampeke ibigori	|__|	|__|
b		Amasaka (igikoma)	|__|	|__|
c		Sorghum (Ikigage, ubushera...)	|__|	|__|
d		*Umuceri*	|__|	|__|
e		*Ingano*	|__|	|__|
f		Ibindi binyampeke	|__|	|__|
g		imyumbati (ubugari cyangwa imiribwa)	|__|	|__|
h		Ibijumba byera	|__|	|__|
i		Ibijumba bias na karoti mo imbere	|__|	|__|
j		ibirayi	|__|	|__|
k		Ibindi binyabijumba	|__|	|__|
l		Amandazi, umugati, capati	|__|	|__|
m		Ibitoki	|__|	|__|
n		Imineke	|__|	|__|
o	Ibinyamisogwe	Ibishyimbo, amashaza n'ibindi binyamisogwe	|__|	|__|
	Imboga	Karoti	|__|	|__|
p		Imboga rwatsi (dodo, pinari, isombe…)	|__|	|__|
q		Ibihaza bisa na karoti mo imbere	|__|	|__|
r		amashu	|__|	|__|
s		Izindi mboga	|__|	|__|
t	ibinyamavuta	Ubunyobwa	|__|	|__|

u		Sova	|__|	|__|
v	Imbuto	Avoka	|__|	|__|
w		Inanasi	|__|	|__|
x		Pome	|__|	|__|
y	Imbuto z' umuhondo	Ipapayi	|__|	|__|
z		Imyembe	|__|	|__|
aa		Icunga	|__|	|__|
ab		Izindi mbuto	|__|	|__|
ac	Ibikomoka ku matungo	Ifi	|__|	|__|
ad		OInyama z'imyanya yo mu nda (umwijima, umutima, izo munda,	|__|	|__|
ae		Inyama (inka, ihene, ingurube, intama urukwavu, inkoko, imbata, izindi…)	|__|	|__|
af		Amagi	|__|	|__|
ag		Amata n'ibiyakomokaho	|__|	|__|
ai	ibinyamavuta	Amavuta , ibinure , ibirunge, amamesa, margarine	|__|	|__|
aj	Ibirungo	Umunyu, urusendaibindi birungo, ibitunguru….)	|__|	|__|
ak		Isukari, ubuki…	|__|	|__|
al		Ibindi…	|__|	|__|

Incuro zibarwa 1= rimwe, 2= inshuro ebyiri 3= inshuro eshatu	4= inshuro enye 5= inshuro eshanu 6= inshuro esheshatu 7= inshuro zirindwi	100=rimwe na rimwe 99=nta na rimwe 50= inshuro inshuro ebyiri ku munsi