UNIVERSITY of RWANDA

College of Medicine and Health Science
School of Public Health

ASSOCIATED FACTORS WITH MALNUTRITION AMONG CHILDREN UNDER 2 YEARS IN RWANDA: A comparative study from Rwanda Demographic and Health Surveys 2000, 2005, 2010 and 2014/15.

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EXECUTIVE SUMMARY

Background: Despite the aggressive commitment and impressive progress in fighting against malnutrition, Rwanda continues facing significant challenges in relation to persistent high levels of chronic malnutrition (though the percentage of stunted children was 43 percent in 2000, 51 percent in 2005, 44 percent in 2010 to 38 percent in 2014/15. However, the proportion of children who are wasted declined from 7 percent in 2000, 5 percent in 2005, 3 percent in 2010 to 2 percent in 2014-15, while the proportion of children who are underweight declined as well, from 18 percent in 2005 to 11 percent in 2010 and 9 percent in 2014-15. Despite improvements in the nutritional status of Rwandan children in the past several years, the prevalence of malnutrition (stunting) is still high, and there remains a need for more intensive research and interventions.

Objectives: The aim of this study was to determine the associated factors with malnutrition among under two-year-old children in Rwanda.

Methods: The present study was based on secondary data of cross-sectional studies that was analyzed to inform us on factors associated with malnutrition among children under two years old in Rwanda, reported to be stunted, wasted and underweight in the Rwanda Demographic and Health Surveys (RDHS) 2000, 2005, 2010 and 2014-15. Data from the four above mentioned RDHS was organized, recorded according to the variable of interest, then statistical analysis was performed through SPSS 16.0 and STATA 13.0. Factors associated with stunting, wasting and underweight were examined using Chi^2 test, bivariate and multivariate analysis full and reduced model. Only statistically significant variables from bivariate analysis were sent to the multivariate analysis reduced model.

Findings: The study revealed a significant association of child's age (6-23 months), child's sex (male), child's low birth weight (<2.500kg), mother's education (no-education), wealth index (poor) and mother nutritional status (underweight), dietary diversity (low dietary diversity), residence (rural), household size (7 persons and more), and water source (non-improved) with malnutrition in children under two years in Rwanda.

Conclusion: This study aimed at exploring secondary data from the DHS 2000, 2005, 2010 and 2014/15, to identify associated factors with malnutrition (stunting, wasting and underweight) and compare the factors associated with malnutrition among under two years children in Rwanda. Based on study findings, there are policy implications because it provides a basis for intensifying interventions to address identified factors (inadequate feeding practices but also socio-demographic and environmental factors), that influence malnutrition. This study reconfirms the importance of nutrition specific and sensitive interventions, especially targeting vulnerable groups such as adolescents, pregnant women, lactating mothers and children under 2 years by engaging men.

RESUME

Contexte : Malgré l'engagement dynamique et les progrès impressionnants réalisés dans la lutte contre la malnutrition, le Rwanda continue de faire face à des défis importants liés à la persistance de taux élevés de malnutrition chronique (bien que la proportion d'enfants présentant un retard de croissance fût 43% en 2000, 51% en 2005, 44%) en 2010, et 38% en 2014/15.

Cependant, la proportion d'enfants émaciés est passée de 7% en 2000 à 5% en 2005 et de 3% en 2010 à 2% en 2014-2015 ; alors que la proportion d'enfants l'insuffisance pondérale a également diminué, passant de 18% en 2005 à 11% en 2010 et à 9% en 2014-2015. Malgré l'amélioration de l'état nutritionnel des enfants Rwandais ces dernières années, la prévalence de la malnutrition, spécifiquement le retard de croissance, reste élevée. Des recherches et des interventions plus poussées demeures nécessaires.

Objectifs : La présente étude avait pour objectif d'identifier les facteurs associés à la malnutrition chez les enfants de moins de deux ans au Rwanda.

Méthodes : La présente étude repose sur des données secondaires d'études transversales analysées pour nous informer sur les facteurs associés à la malnutrition chez les enfants de moins de deux ans au Rwanda, signalant un retard de croissance, une émaciation et un poids insuffisant dans les enquêtes démographiques et santé au Rwanda (EDS) 2000, 2005, 2010 et 2014-15.

Les données des quatre EDS Rwanda susmentionnés ont été organisées, enregistrées en fonction de la variable d'intérêt, puis une analyse statistique a été réalisée en utilisant SPSS 16.0 et STATA 13.0. Les facteurs associés au retard de croissance, d'émaciation et d'insuffisance pondérale ont été examinés à l'aide d'un modèle complet de test du Chi^2, d'analyse bivariée et multivariée.

Seules les variables statistiquement significatives par l'analyse bivariée ont été envoyées au modèle réduit à analyse multivariée.

Résultats: Cette étude a révélé que des facteurs socio-démographiques tels que l'âge de l'enfant (6-23 mois), le sexe de l'enfant (masculin), le faible poids à la naissance de l'enfant (<2.500 kg), le niveau de scolarité de la mère (non scolarisé), l'indice de richesse (pauvre) et l'état nutritionnel de la mère (insuffisance pondérale), la diversité des régimes alimentaires (faible diversité alimentaire), la résidence (rurale), la taille du ménage (7 personnes et plus) et la source d'eau (non-améliorée) étaient significativement associés à la malnutrition chez les enfants de moins de deux ans au Rwanda.

Conclusion: Cette étude visait à explorer les données secondaires de l'EDS 2000, 2005, 2010 et 2014/15, afin d'identifier les facteurs associés à la malnutrition (retard de croissance, l'émaciation et l'insuffisance pondérale) chez les enfants de moins de 2 ans au Rwanda et de comparer les facteurs associés à la malnutrition chez les enfants de moins de deux ans au Rwanda. S'appuyant sur les résultats de notre étude, ces résultats ont une implication sur le plan politique car ils permettent d'intensifier les interventions pour s'attaquer non seulement aux facteurs identifiés (pratiques d'alimentation inadéquates, mais également aux facteurs sociodémographiques et environnementaux) qui influent sur la malnutrition. Notre étude réaffirme l'importance des interventions spécifiques et sensibles à la nutrition, ciblant en particulier les groupes vulnérables (adolescents, femmes enceintes, mères allaitantes et enfants de moins de 2 ans) en faisant participer les hommes.

DEDICATION

This thesis is dedicated to:

The Almighty God, my Fortress, my Strengths
My beloved children and husband for their endless love, sacrifices, tenderness, care and prayers,
My parents for whom the hour rung too early, but who, through their boundless love, generosity, have make me who I am today,
My friends for their prayers and encouragements,
All the people in my life who touch my heart,
Thank you all, for always being there for me! May this work, be the accomplishment of your vows so much alleged, and the fruit of your infallible support,

I dedicate my dissertation.

This thesis has been submitted and approved by my supervisor.

Professor Cyprien MUNYANSHONGORE _____

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ABBREVIATIONS & ACRONYMS

ANC: Antenatal Care

ARIs: Acute Respiratory Infections

BMI: Body Mass Index

CFSVA: Comprehensive Food Security and Vulnerability Analysis

CMHS: College of Medicine and Health Sciences

EDPRS: Economic Development and Poverty Reduction Strategy

FANTA: Food and Nutrition Technical Assistance

GDP: Growth Domestic Product

LBW: Low Birth Weight

LMIC: Low-Middle Income Countries

MINECOFIN: Ministry of Finance and Economic Planning

MoH: Ministry of Health

NCMP: National Child Measurement Programme

NISR: National Institute of Statistics of Rwanda

RDHS: Rwanda Demographic and Health Survey

SD: Standard Deviation

SPH: School of Public Health

SPSS: Statistical Package for the Social Sciences.

UNICEF: United Nations Children's Fund

WHO: World Health Organization

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CHAPTER I. INTRODUCTION

1.1. Definition of key concepts

Malnutrition: refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients. The term malnutrition covers 2 broad groups of conditions. One is 'undernutrition' which includes underweight: weight for age < –2 standard deviations (SD) of the 2006 WHO Child Growth Standards median, stunting: height for age < –2 SD of the 2006 WHO Child Growth Standards median, wasting: weight for height < –2 SD of the 2006 WHO Child Growth Standards median, Overweight: weight for height > +2 SD of the 2006 WHO Child Growth Standards median. Micronutrient deficiencies or insufficiencies (a lack of important vitamins and minerals). The other is overweight, obesity and diet-related noncommunicable diseases (such as heart disease, stroke, diabetes and cancer) (1).

Prevalence: refers to the total number of individuals in a population who have a disease or health condition at a specific period of time, usually expressed as a percentage of the population (2).

Demographic and Health Surveys: The Demographic and Health Surveys (DHS) project is designed to produce accurate and timely information on population, health, and nutrition in developing countries. DHS surveys are national sample surveys that provide key data for planning, monitoring, and evaluating programs in these areas.

1.2. Background

Globally, child malnutrition remains one of the major public health problems in many parts of the world, especially in developing countries. Worldwide, the prevalence of different forms of malnutrition such as stunting (height-for-age), wasting (weight-for-height), and underweight (weight-for-age) in under-five children were 24.7%, 7.8%, and 15.1%, respectively, in 2014. Though child malnutrition remains common all over the world, it is most dominant in developing countries. For example, the prevalence of chronic malnutrition was about 39.9% in Africa, and the prevalence rate of underweight was 26.6% in South-East Asia (3).

It is identified as the major cause of death, with an estimate of 45% of all deaths among children aged 0–59 months of age. In 2017, globally there were 155 million children under 5 years of age were stunted. Stunting affected an estimated 22.9 per cent or 154.8 million children under 5

globally in 2016. Forty one million were overweight, an estimated 6.0 per cent or 40.6 million children under age 5 around the world were overweight in 2016 while 52 million wasted (4). In 2016, wasting continued to threaten the lives of an estimated 7.7 per cent or nearly 52 million children under 5 globally (5).

However, the global current trend in stunting prevalence and numbers affected is decreasing. There would be 130 million stunted children by 2025, which would be 30 million above the global WHA target and despite a 40 percent reduction from 2012 levels (6). Globally, it is estimated that under nutrition is responsible, directly or indirectly, for at least 35% of deaths in children under five years of age. Under nutrition is also a major cause of disability preventing children who survive from reaching their full developmental potential (7).

The wide range of national, social, and economic factors contribute to the explanation and understanding of malnutrition among children and provide a more advanced framework upon which to adopt effective long-term interventions. Studies conducted over the world have indicated that many factors can affect children nutrition. Such factors include socioeconomic status, child or family characteristics, prevalent infectious disease, mothers educational level, limited access to safe drinking water, and poor hygiene, low household wealth index, exposure to open wastewater near the home environment, inadequate purchasing power and access issues, low health literacy and misconceptions regarding proper nutrition and malnutrition, insufficient variety of crops produced. Our review showed that parents' education level, in particular, mothers play a highly important role in their own and children's health. Many studies considered the role of mothers' education level and/or their information about children's nutrition as an effective factor in reducing malnutrition (3).

In developed countries, even in wealthy nations, malnutrition is a serious public health problem. In the United Kingdom, Public Health England (2015a) undertook analysis of a large database of the National Child Measurement Programme (NCMP) data (2006/07 to 2013/14). The authors reported that overall there had been a significant downward trend in the total proportion of underweight children (aged 4-5) over this period. This downward trend was significant for both boys and girls. In addition, a cross sectional study in Liverpool reported that the prevalence of total underweight (The International Obesity Task Force, IOTF), grade I, II & III) (boys and girls) fell

between 1998 and 2006; however, the authors failed to provide information on whether the downward trend was significant. It was also reported a prevalence of underweight boys declined from 10.3% to 6.9%, while the prevalence of underweight girls fell from 10.8% to 7.5%. However, the prevalence of grade II underweight for boys remained similar over the time of a period; while the prevalence of grade II underweight for girls fell. No details were provided by the authors, as to whether the downward trends were statistically significant. A number of infant and child factors were found to be associated with prevalence of underweight in childhood including low birth weight, rates of growth in infancy; Infant weaning and feeding practices and medical conditions The World Bank collection of development indicators of compiled from officially recognized sources, malnutrition prevalence (weight for age) among children under five in United States, was reported at 0.5 % while the Prevalence of wasting (% of children under 5) was at 0.5 %. Malnutrition (stunting) prevalence among children under 5, was reported at 2.1 % (8).

In developing countries, malnutrition continues to be a major public health problem throughout the developing world, particularly in southern Asia and sub-Saharan Africa. The degree and distribution of protein–energy malnutrition and micronutrient deficiencies in a given population depends on many factors: the political and economic situation, the level of education and sanitation, the season and climate conditions, food production, cultural and religious, food customs, breastfeeding habits, prevalence of infectious diseases, the existence and effectiveness of nutrition programs and the availability and quality of health services (9).

A study was carried out to review the malnutrition-dependent factors among under-five children in developing countries It was found that, of the 162 million children under five years who were stunted, 36% of them resided in Africa while 56% were found in Asia. It was also observed that an estimated 60 million under-five children in developing countries were found to be stunted out of which 11 million were Nigerian children. The severity of childhood malnutrition was observed to steadily increase from 11% in 2003 to 18% in 2013 for wasting; 24% in 2003 to 29% in 2013 for underweight, although there was a decline from 42% in 2003 to 37% in 2013 for stunted children and that *mother's education* was associated with malnutrition as children of uneducated mothers are at risk of stunting. Another study found out that stunting was 40.8% higher among children of illiterate mothers, underweight (57.9%) highest among children of mothers who had

attained at least primary education and wasting (33.3%) was common among children of mothers who had tertiary education.

In developing countries, *women's occupation* has been recognized as associated factor with malnutrition given the women's dual roles as primary caregivers to their children and generators of household income. Researchers argued that the more women participate in the labor workforce, the less attention they pay to household responsibilities especially as it relates to the welfare of children, thereby placing younger children at risk of malnutrition. Several studies have indicated that young *maternal age* is associated with high prevalence of malnutrition, while children of older women are less likely to suffer from malnutrition A study carried out in Tanzania reported that children of older mothers are less likely to be malnourished than those of young mothers (10).

In this study, *poverty* was found to be an associated factor with malnutrition, in a sense that, poor household income can lead to less expenditure on food and low nutrient/dietary intake. In another side, they pointed out that a synergistic relationship exists between dietary adequacy, dietary intake and per capita expenditure. Large *family size* may adversely affect the nutritional status of children and household members thereby promoting *poor dietary practices* especially in poorer households. It has been also observed that, in most developing countries, the dietary practice in populations experiencing *food insecurity* tends to meet their energy requirements but do not provide sufficient nutrients to optimize health and prevent infection. Hence, it can be inferred that overnutrition and under-nutrition are strongly associated with food insecurity(10).

A review on "contaminated weaning food: a major risk factor for *diarrhea* and associated malnutrition", provides evidence that food contamination is one of the major contributors to diarrheal diseases and the malnutrition associated with them and that in the prevention of diarrheal diseases in infants and children food safety is as important as breast-feeding or provision of safe water supplies and sanitation(11).

In Argentina, Brazil, Chile and Jamaica, the underweight prevalence is under 2.5%, whereas, at the other extreme, over 10% of the children in Guatemala, Guyana and Haiti are underweight. Stunting is a problem in most (67%) of the countries and, overall, 10% of the population —more than 7 million children— fall into this category.

In Asia, more than half of all stunted children under 5 lived in Asia (56%) and almost half of all overweight children under 5 lived in while more than two thirds of all wasted children under 5 lived in Asia. Though, two out of five stunted children in the world live in Southern Asia. Wasting

in Southern Asia constitutes a critical public health emergency percentage of wasted children under 5, by United Nations sub-region, 2016. More than half of all wasted children in the world live in Southern Asia. Asia is home to the majority of children under 5 suffering from wasting and severe wasting(12). The highest prevalence of wasting in Asia is in India, at around 20%; this is the third highest rate in the world. The lowest rates of wasting in Asia are in Mongolia and Hong Kong, both at approximately 1.5%. The factors that are statistically associated with better nutrition in urban areas are: *Maternal education*: it is more likely that an urban mother will have a secondary education and will have higher decision-making power in her household. *Hygiene and sanitation*: The urban household is more likely to have access to and use a flush toilet, as opposed to open defecation or a pit latrine. *Economic status*: *Urban families also tend to have a better economic status than rural families* (13).

The *Islamic Republic of Pakistan* is among the countries in the world with the highest rates of child malnutrition. Among children under-five, 44% were stunted in 2011 as compared to 41% in the 2001. Fifteen-percent were wasted compared to 14% in 2001 and 31% were underweight, which has not changed since 2001. The malnutrition rates were relatively lower in urban areas compared to rural areas in Pakistan. The prevalence of stunting in the study sample was 48% and was slightly higher (51%) in boys than in girls (45%). The prevalence of wasting in the study area was 16.2 Wasting increased with age, peaking at 20.8% among children in 24–35 months of age. Only 2.5% children were overweight. Overall, 39.5% of children under the age of five years were underweight. The prevalence of underweight for both sexes was almost the same. The rates of underweight increased with age, peaking at 51.6% among children in 24–35 months of age, and then dropped to 37.5% among children in 48–59 months of age. Multiple malnutrition (stunting, wasting and underweight) was higher in boys than girls. Children aged between 12 and 23 months were in more risk for being stunted and underweight than in other age groups.

Association of malnutrition with wealth quintiles presented comparison of underweight, stunting and wasting rates by wealth quintiles. The prevalence of underweight, stunting and wasting was higher in children of poorest households than in children of wealthiest households. Fifty percent children in the poorest households were stunted compared to 42% in the wealthiest households. Children in the poorest households were two times more likely to be wasted (20.6%) compared to children in the wealthiest households (10.3%). A similar relationship was observed between

household wealth and underweight in children (43.8% in poorest and 28.8% in wealthiest households) in the study area. Multiple malnutrition (stunting, wasting and underweight) was higher in boys than girls (14).

The findings showed that determinants related to stunting, wasting and underweight were *mother's education*, *gender*, *age* and *wealth quintiles* was associated with malnutrition. *Diarrhea* was associated with underweight. The p-value of stunting in boys was highly significant <0.0001 relative to girls, but it was not significant for wasting and underweight in the study area. Household *food insecurity* was also positively associated with wasting but not with stunting and underweight in our study area. *Food insecurity* was associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam but not associated with child undernutrition in a study from rural Cambodia. The same study showed the determinants related to stunting, wasting and underweight were *mother's education, parity* and family size were not associated with stunting, wasting and underweight; while *gender*, *age* and *wealth quintiles* was associated with malnutrition. *Diarrhea* was associated with underweight. The p-value of stunting in boys was highly significant (12)

The Sub-Saharan Africa has one of the highest levels of child malnutrition globally. Therefore, a critical look at the distribution of malnutrition within its sub-regions is required to identify the worst affected areas. This study provides a meta-analysis of the prevalence of malnutrition indicators (stunting, wasting and underweight) within four sub-regions of sub-Saharan Africa. The pooled prevalence of malnutrition for all 32 countries in the four sub-regions of SSA was 33.2% (95% CI: 30.4, 36.1) for stunting, 7.1% (95% CI: 6.0, 8.2) for wasting, and 16.3% (95% CI: 12.8, 19.9) for underweight. Exploring undernutrition on a regional basis often masks the differences in the burden of disease within sub-regions. This study investigated the sub-regional prevalence in undernutrition in children under five and reported stunting within countries in East Africa as the highest in the SSA region while wasting and underweight were highest within countries in West Africa (15).

In Ethiopia, malnutrition is a leading cause of child illness and death. Recently the composite index of anthropometric failure (CIAF) has been implemented to measure the prevalence of malnutrition. The rate of malnutrition among under-five children in the country is among the highest in the world and Sub-Saharan Africa. Moreover, malnutrition is the underlying cause for three-fifth of child death in the country. According to the 2014 Ethiopian Mini Demographic and

Health Survey (EMDHS) report, 42%, 26.7%, and 9% of under-five children were stunted, underweight, and wasted, respectively. The problem is even worse in rural areas. For instance, the prevalence of underweight and stunting among rural children was 27% and 42% compared with only 13% and 24% among urban children, respectively. The findings of this study revealed that almost half of children aged 0–59 months were malnourished, and the risk factors were region of residence, education of mother, economic status, age of child, and preceding birth interval (16).

In Nigeria, the DHS 2013 shows 37 percent of children under age 5 are stunted, and 21 percent are severely stunted nationally. *Stunting* is higher in male children (39 percent) than in female children (35 percent). Stunting is higher among children with a preceding birth interval of less than 24 months (41 percent) than among children who were first births and children with a preceding birth interval of 24-47 months or 48 months or more. Nearly one half of children (46 percent) whose perceived size at birth (as reported by the mother) was very small or small are stunted. Mothers' nutritional status, as measured by their body mass index, also has an impact on the level of stunting in their children. Children whose mothers are thin (BMI less than 18.5) have the highest levels of stunting (48 percent), while those whose mothers are overweight or obese (BMI of 25 or above) have the lowest levels (25 percent). Children in rural areas are more likely to be stunted (43 percent) than those in urban areas (26 percent), and the pattern is similar for severe stunting (26 percent in rural areas and 13 percent in urban areas).

Mother's level of education generally has an inverse relationship with stunting; stunting ranges from a low of 13 percent among children whose mothers have a higher education to 50 percent among those whose mothers have no education. A similar inverse relationship is observed between household wealth and stunting. Children in the poorest households are three times as likely to be stunted (54 percent) as children in the wealthiest households (18 percent). The same study report also showed 18 percent of children in Nigeria are wasted. Disaggregation of wasting by child's age shows that wasting is highest (27 percent) among children age 9-11 months and lowest (12 percent) among children age 48-59 months. Male children are more likely to be wasted (19 percent) than female children (17 percent). As expected, the data show a linear relationship between wasting and perceived size of the baby at birth. Wasting is higher (29 percent) among children who were reported to be very small at birth than among those whose perceived size at birth was small, average, or large. Twenty-four percent of children born to mothers who are thin (BMI less than

18.5) are wasted, as compared with 15 percent of those born to mothers who are overweight or obese (BMI of 25 or above). An equal proportion of children in urban and rural areas are wasted (18 percent each). Wasting is generally high in the North West (27 percent) and North East (20 percent) and is lowest in the South West (10 percent). In general, there is an inverse relationship between mother's level of education and wasting, with the lowest proportion of wasting among children of mothers with a higher education (11 percent) and the highest proportion among children of mothers with no education (23 percent). There is a similar inverse relationship between *household wealth* and wasting. Four percent of Nigerian children are overweight. 29 percent of children under age 5 are underweight (weight-for-age below -2 SD), and 12 percent are severely underweight.

The proportion of underweight children is highest (32 percent) among those age 12-17 months and those age 24-35 months. *Male children* are more likely to be underweight (30 percent) than female children (27 percent). *Underweight* also shows a strong relationship with perceived *size of the baby at birth*. Children reported to be very small or small at birth are much more likely to be underweight (43 percent and 37 percent, respectively) than children reported to be average or large at birth (27 percent). Children born to mothers who are thin (BMI less than 18.5) are more likely to be underweight (43 percent) than children born to mothers who are overweight or obese (20 percent). *Rural children* are more likely to be underweight (32 percent) than urban children (23 percent). The study revealed fifty-eight percent of children in Kano and Kaduna are underweight, as compared with only 7 percent in Enugu and 8 percent in Edo.

In Eastern African region: trends in nutritional status of children under 5 years has been in children's nutritional status since 1998 *in Kenya*. Comparison of KDHS data over time indicates an overall improvement in children's nutritional status. Since 1998, stunting has declined from 38 percent to 26 percent, wasting has declined from 7 percent to 4 percent, and the proportion of underweight children has declined from 18 percent to 11 percent (17). A study conducted in a rural community of Southeastern Kenya showed that Chronic malnutrition or among children under 5 years old is affected by several household environmental factors, such as food insecurity, disease burden and poverty.

In Tanzania, the 2015-16 Tanzania demographic and health survey - Malaria Indicator Survey (TDHS-MIS) measured children's nutritional status by comparing height and weight

measurements against an international reference standard. One in three children under five are stunted, or too short for their age. Stunting is an indication of chronic undernutrition. Stunting is more common among children who were very small at birth (51%), those with a thin mother (40%) and those from the poorest households (40%). By region, stunting ranges from 15% in Dar es Salaam to 56% in Rukwa. Wasting (too thin for height), which is a sign of acute malnutrition, is far less common (5%). In addition, 14% of children are underweight, or too thin for their age. The nutritional status of children in Tanzania has improved since 1991-92, when half of children were stunted, compared to 34% in 2015-16(18). About 9% of the children do not receive complementary foods at the critical age of 6 to 9 months. According to a 2004/2005 TDHS, many children below 2 years (24 months) of age do not appropriately receive complementary food, further increasing risks of malnutrition. Although, the causes of malnutrition have been highlighted by different stakeholders such as United Nations Children Education Fund (UNICEF), the relationship between persistent malnutrition and *poor breasting feeding practices*, *timing of complementary food introduction*, *low-nutrient dense complementary foods and their safety* still remains under reviewed. The present review critically explores factors contributing to malnutrition in Tanzania including poor breastfeeding practices and timing of introduction of complementary foods, their low nutrient density and high level of microbial contamination as a major factor to the persistent child malnutrition in Tanzania.

In Rwanda, despite an overall decrease, child under-nutrition remains a public health problem with highly prevalent in developing countries, resulting in substantial increases in mortality and overall disease burden. It is estimated that more than one-third of under-five deaths are attributable to under-nutrition. Despite the aggressive commitment and impressive progress in fighting against malnutrition, Rwanda continues to face significant challenges in relation to persistent high levels of chronic malnutrition (though the percentage of stunted children fell from 42 percent in 2000, 51 percent in 2005 to 44 percent in 2010 and 38 percent in 2014/15. The percentage of children who are wasted declined from 5 percent in 2005 to 3 percent in 2010 and 2 percent in 2014-15, and the proportion of children who are underweight declined from 18 percent in 2005 to 11 percent in 2010 and 9 percent in 2014-15. Although there have been improvements in the nutritional status of Rwandan children in the past several years, the prevalence of malnutrition (stunting) is still high, and there remains a need for more intensive interventions (19). Improvements in nutrition have coincided with economic growth-a 13% reduction in stunting prevalence was seen in the last

decade. However, the most recent figures still show a prevalence of 38% among children under five years, where 24% are moderately stunted and 14% are severely stunted while 2% of children under five years are wasted, and less than 1% are severely wasted (19). The trends in stunting in Rwanda from 2000–2014/2015 for both sex, was 43% in 2000, 51% in 2005, 44% in 2010 and 38% in 2014/2015. Notably, the target of 24.5% by 2015 was one of the only targets that Rwanda did not meet (21).

Therefore, this study intends to explore what are factors associated with stunting, wasting and underweight among children under two years in Rwanda from 2000 to 2014/15. However, stunting continues to be a public health concern in Rwanda despite the strong commitment from the government, together with its development partners and educational institutions, to find solutions. Under the government of Rwanda's leadership, multisectoral initiatives and interventions have been put into place over the past decade aimed at improving of the nation's nutritional status. These efforts include the Presidential Initiative that inspired nationwide emergency action to find and manage all cases of acute malnutrition in children (2009) as follows:

- The government realized the importance of using holistic approaches that bring on board as many stakeholders as possible. Other efforts included: The multisector participation and consensus around Rwanda's First National Nutrition Summit (2009), and Second National Nutrition Summit (2011), Nutrition of Children and Adults
- Completion of health facility and community level tools to more effectively promote and counsel on Maternal, Infant and Young Child Nutrition (MIYCN),
- Development of the National Multisector Strategy to Eliminate Malnutrition (NmSEM) (2010),
- A national Joint Action Plan (2012) to Eliminate Malnutrition (JAPEM) and District Plans to Eliminate Malnutrition (DPEM) in every district (2011).
- Adoption of National Protocol on Management of Malnutrition at the health Facility and Community levels in 2013,
- Establishment of the 2013-2018 National Food and Nutrition Policy and National Food and Nutrition Strategic Plan;
- Promotion of the first 1000 Days campaign". The campaign calls upon Rwandans to cherish the first 1,000 days period right from pregnancy through to the first two years of a

child's life" through Community Based Food and Nutrition program linked with the wide range of key services and practices that helped to enhance household food security;

- Protection of maternal health and fetal growth during pregnancy and prevent stunting during a child's first two years.

Despite the Rwanda's tremendous progress in bringing down the rate of stunting in children under five years of age as above – mentioned, the country also continues to face significant challenges in relation to persistent (though decreasing) high levels of chronic malnutrition (stunting) at 38% of children under-five years which remains a public health concern. To that extend, our research question was: ***What are the factors associated with malnutrition (stunting, wasting and underweight) among children under 2 years in Rwanda?***

1.3. Study objectives

1.3.1. General objective

The aim of our study was to conduct a deep statistical analysis of malnutrition in Rwanda using 2000, 2005, 2010 and 2014/15 DHSs secondary data to determine associated factors with malnutrition among children under two years.

1.3.2. Specific objectives

- To identify associated factors with malnutrition (stunting, wasting and underweight among children under two children in Rwanda.
- To compare risks factors associated with malnutrition among under two years children in Rwanda to evaluate which factor comes back in 2000, 2005, 2010 and 2015.

1.4. Literature review

Globally, malnutrition is a universal issue holding back development with unacceptable human consequences. Yet the opportunity to end malnutrition has never been greater. The burden of malnutrition across the world remains unacceptably high, and progress unacceptably slow. Children under five years of age face multiple burdens: 150.8 million are stunted, 50.5 million are wasted and 38.3 million are overweight. Meanwhile 20 million babies are born of low birth weight each year. Globally, malnutrition is attributable to a wide range of factors including low birth weight, inadequate care and stimulation, insufficient nutrition and recurrent infections, and other environmental determinants (21). Eight risk factors with stunting, for malnutrition and grouped

them into five clusters (maternal nutrition and infection, teenage motherhood and short birth intervals, fetal growth restriction and preterm birth, child nutrition and infection, and environmental factors. The leading risk for malnutrition worldwide was being "term, and small for gestational age" (that is, being born at or after 37 weeks of pregnancy, but being too small), to which 10.8 million cases of malnutrition among two-years old were attributable (out of 44.1 million). This was followed by poor sanitation (7.2 million cases) and diarrhea (5.8 million cases) (22).

According to the 2012 World Bank collection of development indicators of compiled from officially recognized sources, malnutrition prevalence (weight for age) among children under five in United States, was reported at 0.5 % while the Prevalence of wasting (% of children under 5) was at 0.5 %. Malnutrition (stunting) prevalence among children under 5, was reported at 2.1 %.

Within this gloomy picture, there has been progress made in reducing stunting in children under five years of age – the core focus of political commitment to nutrition for some years. Rates have been slowly but steadily declining with global prevalence falling from 32.6% in 2000 to 22.2% in 2017. For example, since 2000, stunting in Nepal declined from 57.1% to 36.0% and in Lesotho from 52.7% to 33.4%. Regionally, Asia has declined from 38.1% to 23.2%; Latin America and the Caribbean from 16.9% to 9.6%; and Africa from 38.3% to 30.3%. Despite the decrease in stunting prevalence in Africa, the number of stunted children has steadily increased from 50.6 million in 2000 to 58.7 million in 2017. Regionally, South Asia is home to 38.9% of the world's stunted children, having the highest burden of the regions.

Wasting and stunting are associated with increased mortality, especially when both are present in the same child. Added to this, it is becoming increasingly clear that children who are wasted are more likely to become stunted and children who are stunted are more likely to become wasted. Children who are moderately or severely wasted have a higher risk of mortality. Wasting still affects 50.5 million children under five with more than half of the world's wasted children, 26.9 million, living in South Asia.

In developed countries: The Public Health in England (2015a) undertook analysis of a large database of NCMP data (2006/07 to 2013/14). The authors reported that overall there had been a significant downward trend in the total proportion of underweight children (aged 4-5) over this period. This downward trend was significant for both boys and girls. In addition, a cross sectional

study in Liverpool reported that the prevalence of total underweight (IOTF, grade I, II & III) (boys and girls) fell between 1998 and 2006; however, the authors failed to provide information on whether the downward trend was significant. The authors reported that the prevalence of underweight boys declined from 10.3% to 6.9%, while the prevalence of underweight girls fell from 10.8% to 7.5%. However, the prevalence of grade II underweight for boys remained similar over the time period; while the prevalence of grade II underweight for girls fell. No details were provided by the authors, as to whether the downward trends were statistically (8). A number of infant and child factors were found to be associated with prevalence of underweight in childhood including: Low birth weight; prematurity; Rates of growth in infancy; Infant weaning and feeding practices and Medical conditions (8).

In developing countries, looking deeper at disaggregated figures, stunting is most prevalent in low and lower middle-income countries: 37.8 million children affected are in low-income countries where the daily average income is less than $2.80 per person per day.24 Another 101.1 million children are in lower-middle-income countries where incomes are less than $11 per person per day. Both the number of people affected (37.0 million) and highest prevalence of wasting (11.5%) occur in lower-middle-income countries and are lowest (0.5 million and 0.7% respectively) in high-income countries. There has been some progress in reducing malnutrition, but it has been too slow and not spread across all forms of malnutrition. Stunting declined from 32.6% of all the world's children under 5 years of age in 2000 to 22.2% in 2017. In numbers this is a decline from 198.4 million to 150.8 million. In Asia, Stunting has declined from 38.1% to 23.2% since 2000 and in Latin America and the Caribbean from 16.9% to 9.6%. In Africa has decreased in percentage terms from 38.3% to 30.3% over the same period, yet due to population growth, the actual number of stunted children has risen. Several countries are on course to meet at least one of the globally adopted nutrition targets set for 2025, but most are off-track and none are making progress on the full suite of targets. Our 2018 assessment of progress against nine targets, which includes new data points from 32 countries, reveals that 94 of the 194 countries included are on track for at least one nutrition target, with 44 of these on track to meet one target and 35 on track to meet two. Of the countries on target, 24 are on track for the stunting target, 37 for wasting and 18 for stunting and wasting. Different forms of malnutrition continue to compound one another – with new analysis further confirming this reality. Of the 141 countries with consistent data on three forms of malnutrition – childhood stunting, anaemia in women of reproductive age and overweight among

women – 88% (124 countries) experience a high level of at least two types of malnutrition, with 29% (41 countries) experiencing high levels of all three. Most of these 41 countries (30) are in Africa. Coexisting burdens bear down on millions of children, with 15.95 million children affected by wasting and stunting, which increases the risk of child mortality, and 8.23 million children affected by stunting and overweight (24).

In developing countries, malnutrition affects one-third of children under 5 years old, and 14% of childhood deaths are attributable to it. The number of malnutrition cases among children aged 24-35 months (i.e., at the end of the 1,000 days' period of vulnerability) that are attributable to 18 risk factors in 137 developing countries(23). At present, Eastern and Western Africa and South-Central Asia have the highest prevalence estimates among United Nations sub-regions (43% in East Africa, 34% in West Africa and 35% in South-Central Asia). Oceania also has a very high rate of malnutrition(38% in 2013) yet contributes little in numbers affected because of its relatively small population (6).

Overall, while there has been progress, millions of children are still suffering from stunting's functional consequences. Extremely high levels appear in countries like Timor Leste, Burundi and Niger, with levels above 50% in most recent surveys. In most countries, malnutrition prevalence among children younger than 5 years is about 2.5 times higher in the lowest wealth quintile compared with the highest (6). Sex inequalities in child malnutrition tend to be substantially smaller than economic inequalities, with rates only slightly higher in boys than in girls. Place of residence is also an important risk factor for stunting, with rates consistently higher in rural than in urban areas (6). Malnutrition continues to be a major public health problem throughout the developing world, particularly in southern Asia and sub-Saharan Africa. It is consequently the most important risk factor for the burden of disease in developing countries. It is the direct cause of about 300 000 deaths per year and is indirectly responsible for about half of all deaths in young children (25).

In Eastern African Region, associated factors with malnutrition increases markedly with a child's age, reaching a level of 40% or more among children age 18-47 months. One in six children age 24-35 months is severely stunted. Children considered very small (51%) or small (46%) at birth are more likely to be stunted than those described as being average or large (33%).

In Tanzania, a recent study conducted, showed that the prevalence of stunted children aged 0–23 months and 0–59 months was 16 and 42 % respectively while the risk of malnutrition was

significantly higher among male children compared to females, rural children, children from the poorest households, children whose mothers were illiterate, in paid employment and resided in the Southern Highlands zone of Tanzania (25). Increased child age was found to be statistically associated with stunted children aged 0-23 months (25).

In Kenya**,** trends in nutritional status of children under 5 years has been in children's nutritional status since 1998. Comparison of KDHS data over time indicates an overall improvement in children's nutritional status in Kenya. Since 1998, malnutrition has declined from 38 percent to 26 percent, wasting has declined from 7 percent to 4 percent, and the proportion of underweight children has declined from 18 percent to 11 percent (17).

*In Rwanda***,** malnutrition remains a major public health concern. The main focus will be on factors related to stunting, wasting and underweight. However, wasting and underweight levels are fairly low across Rwanda: mothers with a low level of education are more often stunted, households most commonly consume water from an improved but untreated source, children in food secure and wealthier households are less likely to be malnourished. Still, some 29 percent of children in food secure households are stunted (26).

The 2000 RDHS shows that, according to age, there are significant variations in the prevalence of chronic malnutrition, moderate or severe. The proportion of children with malnutrition increases very regularly and very rapidly with age. It is before two years that most children are growth and after this age, the delay is no longer catching up (27).

The RDHS 2000, 2005, 2010 and 2014-15, showed that stunting in children under five years stood respectively at 42 per cent, 51 per cent, 44 per cent and 38 per cent while wasting were 7 percent, 4 percent and 3 percent and 24 percent, 23 percent and 9 percent for children underweight (19, 28, 29).

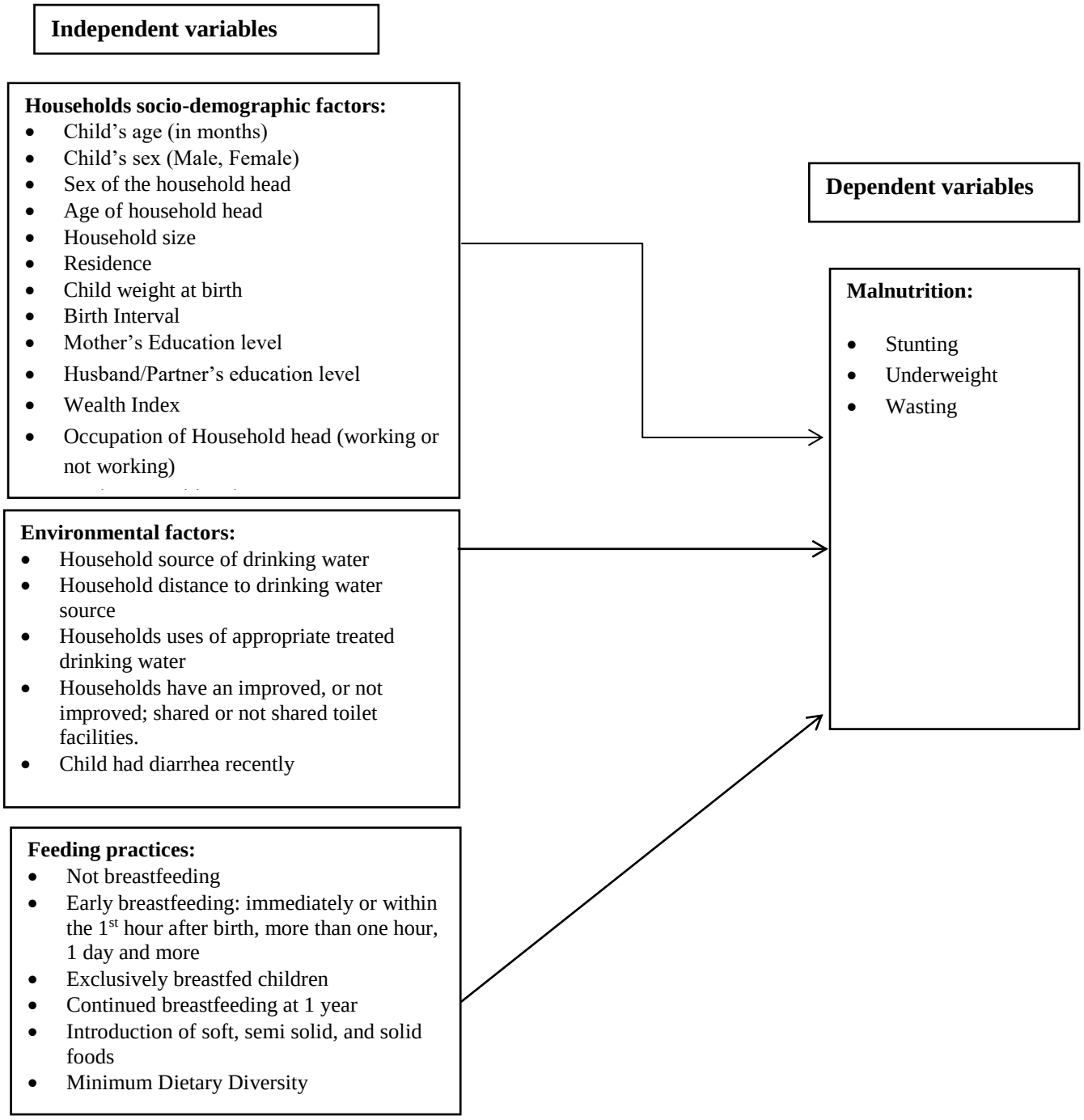
Rwanda has made impressive progress during the last ten years Rwanda has experienced one of the most exciting and fastest periods of growth and socio-economic progress in its history. However, the country also continues to face significant challenges in relation to persistent (though decreasing) high levels of chronic malnutrition (stunting) at 38% of children under-five years (19). This can be explained in part, by difficulties in accessing food, as noted in the 2015 CFSVA, which indicates that 80 percent of all households are food secure and have an acceptable diet and use a low share of their budget to cover food needs. The study conducted in 2013 including key ministries showed high anemia level (48%) in underweight children (30). Underweight costs

Rwanda 65 million Francs per year. The cost of malnutrition is borne mainly the family with a 74% contribution to this burden. An effect on education includes 327,500 children repeating a class and 13% of this is associated with stunting. The cost of the nation on education, is 2.4 billion Francs. The effects on productivity assuming 49 percent of the adult population working had suffered from chronic malnutrition would be estimated at a GDP loss of 9.4% among the working age population for 2012. Rwanda loses 11.5% of her GDP as a result of malnutrition. If there were a 26% reduction stunting, the cost would go down and the country would save an estimated US$ 14 million every year (31). In regard to persistent above-mentioned negative impact of malnutrition on the country, the Government of Rwanda (GOR) is committed to eliminating all forms of malnutrition among children and recognizes the importance of optimal nutrition in achieving national economic and social development goals through access to an age-appropriate balanced diets and living in a favorable healthy environment. The GoR has developed the national EDPRSII (2013 – 2018), the National Food and Nutrition Strategic Plan (2013-2018), the National food and Nutrition Policy Oct.2013 (32), to guide the multi-sectoral implementation approach of the various interventions with special focus to reducing malnutrition in Rwanda which.

Still, there is limited information on the association of stunting, wasting and underweight with social-demographic, environmental and feeding practices factors, among under two years old children in Rwanda.

1.5. Conceptual framework of determining factors of malnutrition

The study explored the different associated factors with malnutrition among children of 6-23 months in Rwanda. The explanatory variables as drawn in the conceptual framework Figure 1, include socio-demographic factors, environmental and feeding practices factors.



Source: Adapted from the UNICEF conceptual framework

CHAPTER II. METHODS AND MATERIALS

2.1. Study area description

2.1.1. Geographical location

Rwanda is a small landlocked country in East Africa also known as the Land of a Thousand Hills'. It is bordered by the Democratic Republic of Congo (DRC) on the West, Tanzania on the East, Uganda on the North, and Burundi on the South. As of 1 January 2018, the population of Rwanda was estimated to be 12,322,920 people. Rwanda population density is 467.8 people per square kilometer (1,211.7/mi^2) as of August 2018(33). The country covers an area of 26,338 km² (10,169 sq. mi.). Rwanda is divided into four geographically Provinces: Northern, Southern, Eastern, and Western Provinces and the City of Kigali. The lower administrative areas consist of 30 Districts, 416 Sectors, 2,148 Cells, and 14,837 Villages (34).

2.2. Study design

The present study used data from cross-sectional studies, the Rwanda Demographic and Health Surveys (RDHS) 2000, 2005, 2010 and 2014-15. The above-mentioned data were used to inform the current study on the associated factors of malnutrition among under two years old children in Rwanda. These data are in the public domain and are available on the DHS program website from which we have an authorizing letter to explore these data. This involved the summary, collation and/or synthesis of existing research, whereas secondary research used primary research sources as a source of data for analysis, compared and analyzed to see if there are statistical correlations between some variables that determine factors of malnutrition among children under two years in Rwanda.

2.3. Specific objective achievements

To identify the socio-economic and demographic factors associated between with malnutrition, among under two years old children in Rwanda in RDHS 2000, 2005, 2010 and 2014/15; secondary data analysis of RDHS 2000, 2005, 2010 and 2014/15 were used. Subsequently, we compared the factors associated with malnutrition among under two years children in Rwanda for the RDHS 2000, 2005, 2010 and 2014/15.

2.3.1. Study variables

Using data sets of the RDHS 2000, 2005, 2010 and 2014-15 that were provided, we did a secondary data analysis on all children under two years. Households socio-demographic, environmental variables and feeding practices indicators: the WHO defined well infant feeding by availing core and optional feeding practice indicators for assessing the adequacy of Infant and Young Child Feeding (IYCF) practices (35). These indicators include early initiation of breastfeeding, Exclusive breastfeeding (EBF) under-6 months, and continued breastfeeding at 1 year, introduction of solid, semi-solid, or soft foods, minimum dietary diversity and bottle feeding (4). The sub-optimal feeding practice was defined as compliance deviation to any of these recommended practices.

2.3.1.1. Outcome variable

The outcome variable of our study was malnutrition (stunting, wasting and underweight) among children under 2 years. From the present study, Stunting, Wasting and Underweight which are respectively a linear growth delay if their height-for-age is less than two standard deviations below the WHO Child Growth Standards median, was retained as outcome variable.

2.3.1.2. Explanatory variables

Age of the child: This variable stands for months/years of child in months and was grouped into 2 groups: 0-6 months and 6-23 months.

Sex of the child: represents whether the child is male or a female.

Sex of the household head: This variable means that the head of the household is a male and a female

Age of household head: This variable stands for years of the and was grouped into 2 groups: less than 50 and more than 50

Household size: this variable refers to the number of household members categorized in 3 groups: 1-3 persons, 4-6 persons, 7 or more.

Place of residence: Means whether the respondent was living in rural or urban area

Child weight at birth: Refers to the body weight of a baby at its birth. The range of normal is between 2.5 kilograms.

Birth Interval: refers to how soon after a prior pregnancy a woman becomes pregnant or gives birth again and was categorized into 3 groups: <24, 24 to 47, and 48+.

Mother's Education level: this variable refers to the highest level of education attained by the mother that was categorized in 3 groups: No education, primary education and secondary and higher.

Husband/Partner's education level: It refers to the highest level of education attained by the husband that was categorized in 3 groups: No education, primary education and secondary and higher.

Wealth Index: this variable refers to a composite measure of a household's cumulative living standard (ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities). In this study, households were categorized into three categories: rich, middle and poor.

Occupation of Household head: Whether the head of the household was working or not working.

Household source of drinking water: this variable refers to whether the household use improved or not improved water.

Household distance to drinking water source: this variable refers to the distance that the household uses to access to water source.

Child had diarrhea recently: this variable refers to the child who had diarrhea prior to the survey.

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 were fed exclusively with breast milk.

Introduction of soft, semi-solid or solid foods: Percentage of infants between 6–8 months of age received soft, semi-solid or solid 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;

2.3.2. Analysis plan

The data from the four DHS (2000, 2005, 2010, 2014/15) were organized and recorded according to the variables of interest. Statistical analysis was performed using SPSS 22.0 and STATA 13.0. The associated factors with stunting, wasting and underweight were respectively determined using Chi^2 test and binary logistic regression. The Chi^2 test was used to test the relationship between the independent variables (i.e. household socio-demographic factors, environmental factors and feeding practices) and the dependent variable (i.e. stunting, wasting and underweight). On the other hand, bivariate and multivariate analysis full and reduced model were performed to explain the relationship between dependent variable (malnutrition: stunting, wasting, underweight) and independent variables (household socio-demographic, environmental and feeding practices factors). Only statistical significant variables (p value <0.05) were sent to the multivariate analysis reduced model.

These characteristics were grouped and processed according to the descriptive statistics and cross tabulation to describe the demographic, socio-economic and Environmental (hygiene status). For feeding practices of children below two years old, indicators were calculated as recommended by WHO (35).

2.4. Study population

2.4.1. Sample size calculation

The study used secondary data and the sample population from RDHS 2000, 2005, 2010, and 2014/15. We were particularly interested by children under two years. As reported by the DHS, the population of our study was in DHSs 2000 (2,844), 2005 (1,608), 2010 (1,535), and 2014/15 (1,488). Thus, the total sample size of this study was calculated at 7,475. However, some variables in this was computed among children whose mothers interviewed such as feeding practices variables, diarrhea episodes.

2.4.2. Sampling techniques

In all households, the eligibility criteria for participation in the four surveys, was being women and men aged 15–49 years. The datasets from sample distributions of women and men aged 15-59 who responded and were grouped by five-year age increments that provided households socio-demographic profile (available at the DHS Program and NISR website). The sampling techniques

were based on the sample size measured in RDHS (2000, 2005, 2010 and 2014/15), which was nationally representative based on all women age 15-49 who were either permanent residents of the household or visitors present in the household on the night before the survey were eligible to be interviewed.

For the 2000 RDHS, a total of 9,696 households with children under five years represented the sample. Among these households, 10,421 women and 2,717 men aged 15 – 59 were surveyed. In DHS 2005, the sample was 12,540 households with children under five years represented the sample were surveyed, 13,671 women were surveyed in addition to a total of 6,329 men aged 15-59 who completed the individual interviews, for the 2010 RDHS, the sample that was used was 12,540 households with children under five years and 13,671 women aged 15-59 who completed interviews and 6,329 males aged 15-49 the individual interviews. In addition, in 2014/15 RDHS, a total number of 12,699 households surveyed with children under five years represented the sample, 13,497 women aged 15-49 and 6,217 men aged 15-59 were used, while.

For both DHS 2000, 2005, 2010 & 2014/15, the sampling frame used consisted of a list of enumeration areas. A two-stage sample design was used and intended to allow estimates of key indicators at the national level. However, as our study was interested by secondary data from all the above four DHSs, the eligibility criteria for participation was being a household with children under two years and which was surveyed in all DHSs 2000, 2005, 2010 and 2014/15 for malnutrition (stunting, wasting and underweight).

2.4.3. Data collection procedures

The data used for this study were available as secondary data from DHS 2000, 2005, 2010 and 2014/2014/15 dataset. There were no specific collection methods.

For both RDHS 2000, 2005, 2010 and 2014/15; anthropometric data measurements were taken for children to determine their nutritional status (stunting, wasting and underweight). The measures helped to calculate the universally recognized indicators that were used to reflect the nutritional status of children, including height-for-age for stunting, weight/age for underweight and weight/height for wasting. For this study, we focused specifically on malnutrition indicators for the four RDHS.

2.5. Materials

2.5.1. Study tools (questionnaire)

For all the RDHS 2000, 2005, 2010 and RDHS 2014/15, three types of questionnaires, developed by the worldwide DHS Program were used; the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire. To reflect relevant issues in population and health in Rwanda, the questionnaires were adapted during a series of technical meetings with various stakeholders from Government ministries and agencies, non-governmental organizations, and international donors. Again, while having used secondary data from the four DHSs datasets, there was no questionnaire that was used for the current study.

2.6. Policy implication

The results of the research will be presented to the University of Rwanda, College of Medicine and Health Sciences, School of Public Health in a public defense. In addition, the results will be disseminated in relevant meetings such as the National Nutrition Working Group meeting for the government and its Partners and other stakeholders to inform policy makers for evidence-based decisions concerning the reduction of malnutrition among under two years children.

2.7. Ethical consideration

This study was conducted exclusively using secondary and existing datasets and therefore, did not require Institutional Review Board. However, as the present study used a database from RDHS 2000, 2005, 2010 and 2014/15, an online registration was done, and a prior approval from the DHS Program has been secured before accessing the database, as shown in the DHS Program authorization letter attached in annex No 1.

CHAPTER III. RESULTS

3.1. Household socio - demographic characteristics

The results of the household socio-demographic characteristics in Table 1, indicated that, the number of children aged between 6–23 months were predominant at 68.4% in 2000, 68.0% in 2005, 73.0% in 2010 while in 2014/15 they were at 72.0%.

Among children of our study, males and females were respectively 48.0% versus 52.0% in 2000, 50.7% versus 49.3% in 2005, 49.9% against 50.1% in 2010 while in 2014/15 they were at 50.1% against 49.9% of females.

Households are predominantly headed by males compared to those which are headed by females in all years (82.8% in 2000, 82.0% in 2005, 79.5% in 2010 and 80.1% in 2014/15) whereas household head less than 50 years old were the majority (91.6% in 2000, 89% in 2005, 88.5% in 2010 while 87.6% in 2014/15), than those who were aged more than 50 years.

Additionally, the DHS results summarized in Table 1 revealed that households size of 4 – 6 persons were predominantly at 55.8% in 2000, 55.2% in 2005, 52.2% in 2010 and 58.1% in 2014/15. Likewise, Table 1 revealed that majority of respondents were living in rural areas at 77.6% in 2000, 80.4% in 2005, 86.4% in 2010 and 76.8 % in 2014/15.

Also, 74.5% of children in 2000, 77.5% in 2005, 75.6% in 2010 and 78.2% in 2014/15, had the normal child birth weight, while 5.6%, 3.9%, 5.3% and 5.9 had low birth weight respectively in 2000, 2005, 2010 and 2014/15. However, 19.9% in 2000, 18.7% in 2005, 19.2% in 2010 and 15.9% were overweight at their birth.

Moreover, predominant birth interval was found at 24 – 47 months 60.7% in 2000, 60.3% in 2005, 58.3% in 2010 and 49.0% in 2014/15. However, the following high rate of this variable was found almost similar rate at <24 months and 48 months and more where it was respectively found that 20.7% in 2000, 22.6% in 2005, 19.8% in 2010 and 13.1% in 2014/15 while 18.6% in 2000, 17.15 in 2005, 22.0% in 2010 and 37.9% in 2014/15.

Furthermore, the results in Table 1 revealed that majority 56.6% of mothers had primary education level in 2000, compared to 52.2% in 2005, 72.4% in 2010 and 72.1% in 2014/15. In the same way, 30.4%, 26.3%, 17.3% and 11.7% of the mothers who had no education in 2000, 2005, 2010 and

2014/15 respectively. However, those with secondary education remained low with the numbers continuing to fluctuate over the years, though it was lowest in 2010 with only 10.2% percent representation. Similarly, the same in Table 1 revealed that the majority of husbands/partners were 55.2% with primary education level in 2000, compared to 61.4% in 2005, 69.7% in 2010 and 70.7% in 2014/15. Also, 29.5%, 26.4%, 18.5% and 15.4% of the husbands/partners had no education in 2000, 2005, 2010 and 2014/15 respectively. Though, the rate of those with secondary education was the lowest in 2010 with only 10.1% percent.

Additionally, 45.5% of the respondents had the lowest wealth quintile in 2010 than in 2005 and 2014/15 where results respectively show 45.1% in 2014/15 and 40.4%. Those with middle wealth quintile were the majority Accordingly, majority of the rich population was 39.6% in the DHS of 2005, followed by 37.0% in 2014/15 and 35.1% in 2010, compared to 20.1% in 2005, 19.4% in 2010 and finally 17.9% in 2014/15 for the middle class. There was however, no data for the wealth quintile of the DHS of 2000.

Likewise, these results on socio-economic characteristics show that a big number of heads of households were working. They were 82.5% in 2000, 66.7% in 2005, 76.5% in 2010 while 83.3% in 2014/15. However, non-neglected number of 17.5% in 2000, 33.3% in 2005, 23.5% in 2010 and 16.7% % in 2014/15 were not working.

Moreover, the same results in Table 1, revealed that majority of the respondents were 80.6%, 84.1%, 79.1% and 73.9% respectively had normal nutritional status in 2000, 2005, 2010 and 2014/15. Fewer mothers 11.7%, 9.7%, 14.1% and 17.1% were overweight in 2000, 2005, 2010 and 2014/15 and only 5.8%, 5.4%, 4.9% and 4.9% were underweight in both 2000, 2005, 2010 and 2014/15 DHS reports.

Moving forward, the results in Table 1, showed majority new born were put on breast immediately or within the first hour of birth at a rate of 47.9% in 2000, 67.8% in 2005, 72.0% in 2010 and 80.1% while 26.5%, 22%, 23.0% and 16.6% of new born were respectively put on breast with more than those who were put on breast one hour after birth. However, the results in the same Table 1, revealed majority of babies who were not exclusively breastfed from 0-5months were 60.7% in 2000, 60.0% in 2005, but decreased proportion in 2010 at 22.3% and in 2014/15 at 24.5%.

Though, the exclusive breastfeeding rate was low in 2000 and 2005 respectively at 39.3% in 2000 and 40.0% in 2005 but highly increased in 2010 and 2014/15 respectively at 77.7% and 75.5%.

Additionally, it was shown that the introduction of soft, semi-solid and solid foods was applied at 71.4% in 2010 and 69.8% in 2014/15 whereas 28.6% and 30.2% respectively in 2010 and 2014/15 did not introduced complementary food. There was however, no data for the introduction of solid, semi-solid and soft foods in the 2000 and 2005 DHS.

Furthermore, the Table 1 showed that the child minimum acceptable diet was low among majority of children at 60.4% in 2000, 79.8% in 2005, 76.3% in 2010 but decreased at 44.6% in 2014/15. Though, those who met the minimum dietary diversity were at 39.6%, 20.2%, 23.7% and 55.4% respectively in 2000, 2005, 2010 and 2014/15.

The results presented in Table1, revealed that minority of the surveyed population had access to improved source of water as per 41.3% in 2000, 40.7% in 2005, 35.5% in 2010 42.1% in 2014/15. Nevertheless, majority of the same population had no access to improved water at 58.7% in 2000, 59.3% in 2005, 64.4% in 2010 and 57.9% in 2014/15.

Similarly, the greatest of respondents had drinking water in their compounds at 90.4%, 88.5%, 91.0% and 90.2% respectively in 2000, 2005, 2010 and 2014/15 while 9.6%, 11.5%, 9.0% and 9,8% had access to drinking water in less than 30 minutes respectively in 2000, 2005, 2010 and 2014/15. In addition, 50.7% of the population in 2010 could treat their water prior to drinking, though this number decreased in 2014/15 to 43.1%. There was no data on the same variable in the 2000 and 2005 DHSs.

On the other hand, the highest number of the population could access improved, not shared toilet facilities in 2000, 2005, 2010 and 2014/15 with a representation of 80.0%, 81.6%, 56.9% and 52.6% respectively. However, the population that had access to improved but shared toilet was 16.9% in 2000, 14.7% in 2005, 15.9% in 2010 and 17.6% in 2014/15. Unfortunately, the population that had no access to unimproved kept on increasing over the years from 3.1% in 2000, 3.6% in 2005, 27.2% in 2010 but increased to 29.8% in 2014/15.

Lastly, Table 1 showed that the greatest number of respondents 74.7%, 79.4%, 79,7% and 81.9% hadn't diarrhea few days preceding the survey. Unfortunately, 25.3% in 2000, 20.6% in 2005, 20,3% in 2010 and 18.1% in 2014/15 had diarrhea few days preceding the survey.

TABLE 1: HOUSEHOLD SOCIO-DEMOGRAPHIC CHARACTERISTICS

Factor	Level	DHS_2000 (N=2844)	DHS_2005 (N=1608)	DHS_2010 (N=1535)	DHS_2014/15 (N=1488)
Age of child (in months)	0-5	898 (31.6%)	515 (32.0%)	415 (27.0%)	417 (28.0%)
	6-23	1945 (68.4%)	1093 (68.0%)	1120 (73.0%)	1071 (72.0%)
Sex of the child	Male	1367 (48.0%)	778 (50.7%)	743 (49.9%)	806 (50.1%)
	Female	1478 (52.0%)	757 (49.3%)	745 (50.1%)	803 (49.9%)
Sex of household head	Male	2356 (82.8%)	1319 (82.0%)	1218 (79.3%)	1192 (80.1%)
	Female	488 (17.2%)	289 (18.0%)	317 (20.7%)	296 (19.9%)
Age of head of household	Less than 50	2604 (91.6%)	1439 (89.5%)	1358 (88.5%)	1304 (87.6%)
	More than 50	240 (8.4%)	169 (10.5%)	177 (11.5%)	184 (12.4%)
Household size	1-3 persons	448 (15.8%)	269 (16.7%)	332 (21.6%)	307 (20.6%)
	4 to 6 persons	1587 (55.8%)	887 (55.2%)	802 (52.2%)	864 (58.1%)
	7 or more	809 (28.4%)	452 (28.1%)	401 (26.1%)	317 (21.3%)
Type of place of residence	Urban	637 (22.4%)	315 (19.6%)	208 (13.6%)	345 (23.2%)
	Rural	2207 (77.6%)	1293 (80.4%)	1327 (86.4%)	1143 (76.8%)
Child weight at birth	Low weight	48 (5.6%)	20 (3.9%)	62 (5.3%)	84 (5.9%)
	Normal	637 (74.5%)	402 (77.5%)	890 (75.6%)	1105 (78.2%)
	Overweight/obese	170 (19.9%)	97 (18.7%)	226 (19.2%)	224 (15.9%)
Mother's education level	No education	864 (30.4%)	423 (26.3%)	266 (17.3%)	174 (11.7%)
	Primary	1611 (56.6%)	839 (52.2%)	1112 (72.4%)	1073 (72.1%)
	Secondary or higher	369 (13.0%)	346 (21.5%)	157 (10.2%)	241 (16.2%)
Partner's educational attainment	No education	806 (29.5%)	403 (26.4%)	258 (18.5%)	204 (15.4%)
	Primary or lower	1509 (55.2%)	937 (61.4%)	970 (69.7%)	935 (70.7%)
	Secondary	374 (13.7%)	170 (11.1%)	140 (10.1%)	135 (10.2%)
	Tertiary	47 (1.7%)	17 (1.1%)	24 (1.7%)	49 (3.7%)
Wealth index	Rich		636 (39.6%)	539 (35.1%)	551 (37.0%)
	Middle		323 (20.1%)	298 (19.4%)	266 (17.9%)
	Poor		649 (40.4%)	698 (45.5%)	671 (45.1%)

Occupation head of household	Not working	497 (17.5%)	536 (33.3%)	360 (23.5%)	248 (16.7%)
	Working	2344 (82.5%)	1072 (66.7%)	1175 (76.5%)	1239 (83.3%)
Mother nutritional status	Underweight	140 (5.8%)	74 (5.4%)	67 (4.9%)	64 (4.9%)
	Normal	1938 (80.6%)	1157 (84.1%)	1089 (79.1%)	974 (73.9%)
	Overweight	282 (11.7%)	134 (9.7%)	194 (14.1%)	225 (17.1%)
	Obese	43 (1.8%)	11 (0.8%)	26 (1.9%)	55 (4.2%)
Breastfeeding status	Immediately or within first hour	1353 (47.9%)	1087 (67.8%)	1103 (72.0%)	1188 (80.1%)
	More than one hour	750 (26.5%)	353 (22.0%)	352 (23.0%)	246 (16.6%)
	One day or more	723 (25.6%)	162 (10.1%)	73 (4.8%)	50 (3.4%)
Exclusively breastfed children (0-5 months)	Yes	1119 (39.3%)	643 (40.0%)	1193 (77.7%)	1124 (75.5%)
	No	1725 (60.7%)	965 (60.0%)	342 (22.3%)	364 (24.5%)
Introduction solid, semi solid or soft foods	No			439 (28.6%)	450 (30.2%)
	Yes			1096 (71.4%)	1038 (69.8%)
Child minimum dietary diversity	Low dietary	1718 (60.4%)	1225 (79.8%)	1135 (76.3%)	718 (44.6%)
	Acceptable minimum dietary	1127 (39.6%)	310 (20.2%)	353 (23.7%)	891 (55.4%)
Source of drinking water	Improved	1173 (41.3%)	654 (40.7%)	545 (35.5%)	626 (42.1%)
	Not Improved	1669 (58.7%)	954 (59.3%)	989 (64.4%)	861 (57.9%)
Distance to drinking water	In the compound	2570 (90.4%)	1423 (88.5%)	1397 (91.0%)	1342 (90.2%)
	Less than 30 minutes	274 (9.6%)	185 (11.5%)	138 (9.0%)	146 (9.8%)
Water treatment	Not treated			756 (49.3%)	846 (56.9%)
	Treated			779 (50.7%)	642 (43.1%)
Toilet type	Improved toilet not shared	2258 (80.0%)	1303 (81.6%)	872 (56.9%)	783 (52.6%)
	Improved toilet but shared	477 (16.9%)	235 (14.7%)	244 (15.9%)	262 (17.6%)
	Unimproved toilet	87 (3.1%)	58 (3.6%)	417 (27.2%)	443 (29.8%)
Had diarrhea recently	No	2123 (74.7%)	1277 (79.4%)	1223 (79.7%)	1218 (81.9%)
	Yes	718 (25.3%)	331 (20.6%)	312 (20.3%)	270 (18.1%)

3.2. Bivariate analysis of Stunting and socio-demographic characteristics

As shown in Table 2, the proportion of children stunted was higher in those aged 6 to 23 months (42.7%, 46.9%, 40.6% and 37.2% respectively in 2000, 2005, 2010 and 2014/15 than in those aged 0 to 6 months whose proportion was 9.7%, 9.7%, 15.3% and 11.7% respectively in 2000, 2005, 2010 and 2014/15. The results also revealed a higher proportion of stunted children in boys at 34.6%, 37.8%, 38.9% and 37.3% respectively in 2000, 2005, 2010 and 2014/15, compared to 30.3% in 2000, 33.6% in 2005, 28.9% in 2010 and 23.3% in 2014/15 in girls of the same age in all the four DHSs. In addition, a higher proportion of stunted children was found among children born with low birth weight (<2.5Kg) at 40%, 47.7%, 46.9% and 52.7% of children respectively in 2000, 2005, 2010 and 2014/15 than 20.6%, 30.4%, 31.9% and 29.7% of children born with normal birth weight in all DHSs 2000, 2010 and 2014/15.

Furthermore, the results showed the higher proportion of stunted children in rural area at 34.3%, 37.5%, 35.2% and 32.2% respectively in 2000, 2005, 2010 and 2014/15 than in urban area where the proportion was 22.1%, 23.9%, 23% and 20.7% respectively. The results discovered a higher proportion of stunted children born to the non-educated mothers 36.4%, 40.2%, 40.6% and 34.6% respectively in 2000, 2005, 2010 and 2014/15 while the proportion of stunted children born to mothers with secondary and higher education was at 21.3%, 14.9% and 19.2% respectively in 2000, 2010 and 2014/5.

In addition, results showed higher proportion of stunted children born to underweight mothers at 34.8%, 38.6%, 39.9% and 40% respectively in 2000, 2005, 2010 and 2014/15; than those born of mothers with normal nutritional status. Furthermore, the higher proportion of stunted children of 40%, 40.4% and 36.9 respectively in 2005, 2010 and 2014/2015 were living in poor households, than those living in rich households whose proportion was 30.9%, 23.2% and 21.8% in 2005, 2010 in 2014/15 respectively. Moreover, results showed most of stunted children in households who used not improved drinking water 34.6%, 36.3%, 35.9% and 32.8% respectively in 2000, 2005, 2010 and 2014/15 compared to those who were living in households using improved drinking water.

In addition, the results indicated that the higher proportion stunted children 39%, 44.4%, 39.5% and 39.1% respectively in 2000, 2005, 2010 and 2014/15, in those who had recent diarrhea before the survey while the lower proportion was found in those who did not have recent diarrhea before

the survey. Moreover, it was found that the higher proportion of stunted children was among those who were fed with low dietary diversity 38.5%, 45.4% 31.9% respectively in 2000, 2005, 2010 than those who were fed with acceptable diet in 2014/15 than 28.9%, 23%, 25,5% in 2000, 2005, 2010 respectively. Additionally, higher proportion of stunted children were 40,7% and 36.7% who received soft, semi-solid and solid foods than 16.2% and 14.8% who didn't receive any food.

TABLE 2: BIVARIATE ANALYSIS OF STUNTING AND SOCIO-DEMOGRAPHIC CHARACTERISTICS

Variables	2000				2005				2010				2014-15			
	% stunted	Total	chi2	*p* value	% stunted	Total	chi2	*p* value	% stunted	Total	chi2	*p* value	% stunted	Total	chi2	*p* value
Age (in months)																
0-5	9.7	802	225.074	0.000	10	451	388.6	0.000	15.3	403	167.739	0.000	11.7	397	183.4099	0.001
6-23	42.7	1,790			46.9	1,042			40.6	1,103			37.2	1059		
Total	32.5	2,592			35.7	1,493			33.8	1,507			30.2	1457		
Sex of child																
Male	34.6	1,331	5.2975	0.022	37.8	753	5.768	0.120	38.9	739	33.7829	0.000	37.3	721	70.7603	0.001
Female	30.3	1,260			33.6	740			28.9	768			23.3	736		
Total	32.5	2,592			35.7	1,493			33.8	1,507			30.2	1,457		
Previous birth interval																
<24	32.8	423	1.8467	0.482	37.4	269	7.99	0.192	39.2	215	4.2629	0.408	26.2	139	3.9538	0.434
24-47	33.8	1,300			34.5	761			35.8	622			31.8	529		
48+	30.2	416			41.4	201			33.1	234			30.6	412		
Total	32.9	2,140			36.2	1,232			35.9	1,070			30.6	1,079		
Child weight at birth																
Overweight/obese	18.7	131	10.4023	0.017	25.2	90	14.99	0.177	25.5	223	24.7523	0.007	22.3	221	54.3704	0.001
Normal	20.6	491			30.4	352			31.9	865			29.7	1,082		
Low weight	40	39			47.7	15			46.9	63			52.7	78		
Total	21.4	2592			29.9	457			31.5	1,151			29.8	1,380		
Type of place of residence																
Urban	22.1	380	21.7981	0.000	23.9	196	28.47	0.000	23	174	20.6292	0.004	20.7	251	26.8548	0.001
Rural	34.3	2,212			37.5	1,297			35.2	1,333			32.2	1,206		
Total	32.5	2,592			35.7	1,493			33.8	1,507			30.2	1,457		
Mother's education level																
No education	36.4	844	22.2732	0.000	40.2	397	10.47	0.083	40.6	270	27.9062	0.000	34.6	173	31.6958	0.001
Primary	32.4	1,461			33.6	778			34.5	1,097			31.8	1,065		
Secondary or higher	21.3	287			35.2	318			14.9	139			19.2	219		
Total	32.5	2,592			35.7	1493			33.8	1,507			30.2	1,457		
Wealth index																
Rich					30.9	531	22.29	0.005	23.2	513	80.8119	0.000	21.8	505	64.5689	0.001
Middle					35.1	314			36.8	295			29.4	277		
Poor					40	648			40.4	699			36.9	675		
Total					35.7	1493			33.8	1507			30.2	1457		

Source of drinking water																
Improved	28.9	987	9.0679	0.007	34.7	579	0.805	0.569	30	525	11.4944	0.068	26.4	595	14.3616	0.013
Not Improved	34.6	1,602			36.3	914			35.9	981			32.8	861		
Total	32.4	2589			35.7	1493							30.2	1456		
Toilet type																
Improved toilet not shared	32.9	2129	3.639	0.209	35.8	1229	6.295	0.237	32.3	862	33.6481	0.000	28.7	770	12.545	0.065
Improved toilet but shared	29.6	361			32.6	194			26.2	228			27.2	248		
Unimproved toilet	40.2	80			45.1	57			41.2	415			34.7	439		
Total	32.7	2569			35.7	1480			33.8	1505			30.2	1457		
Breastfeeding status																
Early breastfeeding	23.3	1,175	0.4573	0.819	34.1	1014	7.409	0.211	32.3	1085	8.1375	0.300	29.6	1169	8.2233	0.158
One hour or more	24.6	696			38.8	316			36.9	341			30.9	238		
One day or more	24	703			39.8	161			39.8	79			43.3	46		
Total	23.8	2,575			35.7	1491			33.8	1505			30.3	1453		
Husband/partner's educational level																
No education	37.8	256	19.611	0.063	39.2	387	7.571	0.344	37.8	256	19.611	0.063	39.3	203	33.7358	0.003
Primary or lower	35.2	968			35.9	878			35.2	968			29.3	936		
Secondary	22.8	126			31.7	146			22.8	126			26.9	127		
Tertiary	28.8	21			24.1	11			28.8	21			10.5	35		
Total	34.4	1,370			36.3	1,422			34.4	1,370			30.2	1,301		
Mother's nutritional (BMI) status																
Underweight	34.8	130	14.5389	0.003	38.6	68	12.41	0.209	39.9	68	30.8647	0.002	40	65	33.3643	0.002
Normal	34.3	1,856			37.9	1,114			36	1,075			32.8	964		
Overweight	26.8	254			28.2	123			22.4	185			22.6	217		
Obese	7.8	30			21.5	10			26.6	25			17.9	51		
Total	33.2	2,269			36.9	1,315			34.2	1,353			30.9	1,297		
Had diarrhea recently																
No	30.1	1,916	17.7797	0.000	33.4	1,179	27.08	0.001	32.3	1,201	11.2245	0.019	28.2	1,186	25.5211	0.001
Yes	39	673			44.4	314			39.5	306			39.1	271		
Total	32.4	2,589			35.7	1,493			33.8	1,507			30.2	1,457		

Minimum acceptable diet																
Acceptable diet	28.9	1,620	25.4499	0.000	23	644	167	0.000	25.5	223	24.7523	0.007	30.3	1,118	0.0508	0.885
Low dietary diversity	38.5	971			45.4	849			31.9	865			29.9	339		
Total	32.5	2,592			35.7	1,493			46.9	63			30.2	1,457		
Water treatment																
Not treated									36.8	755	11.8453	0.012	30.8	850	0.711	0.561
Treated									30.8	752			29.4	607		
Total									33.8	1,507			30.2	1,457		
Introduction of soft, semi-solid, solid foods																
No									16.2	423	163.294	0.000	14.8	430	141.8796	0.000
Yes									40.7	1,084			36.7	1,027		
Total									33.8	1,507			30.2	1,457		
Distance to drinking water																
In the compound	33.1	2,340	4.2479	0.054	35.2	1,326	2.398	0.345	34	1,368	0.6447	0.581	30.1	1,316	0.0743	0.842
Less than 30 min	26.7	252			39.5	166			31.6	139			30.9	141		
Total	32.5	2,592			35.7	1,493			33.8	1,507			30.2	1,457		
Exclusively breastfed children																
Yes									38.5	1,177	104.776	0.000	35.6	1,110	132.9113	0.842
No									17.1	330			13	347		
Total									33.8	1,507			30.2	1,457		
Sex of head of household																
Male	32.9	2,162	1.1289	0.291	35.6	1,224	0.053	0.883	34	1,197	0.1588	0.79	29.5	1,171	3.0146	0.245
Female	30.3	430			36.1	269			33.1	310			33.2	286		
Total	32.5	2,592			35.7	1,493			33.8	1,507			30.2	1,457		

3.3. Bivariate analysis of Wasting and socio-demographic characteristics

As shown in Table 3, results revealed the higher proportion of 10.9%, 7.6%, 4.8% of wasted in children aged of 6 to 23 months respectively in 2000, 2005, 2010 except in 2014/15 where the proportion was the lower compared to children aged of 0 to 6 months in the same year. However, the study revealed that the lower proportion of wasted children was to 5%, 3.1%, 4,6% and 5.3% in aged of children aged except in those of the same age in 2014/15 where the proportion was 5.3%. Also, a higher proportion of wasted children < 2 years was found in boys at 10.7%, 6.9%, 6% and 4.1% respectively in 2000, 2005, 2010 and 2014/15 compared to their counterpart girls who's the proportion was 7.3%, 5.6%, 3.6% and 3.8% in respective years.

Likewise, the study indicated the higher proportion 18.3%, 37%, 24.9% and 10.4% in 2000, 2005, 2010 and 2014/15 of wasted children who were born to underweight mothers (BMI<18.5), in 2000, 2005, 2010 and 2014/15 respectively, than those born to mothers with normal weight at the lower proportion of 9.5%, 24.6%, 11.1%, 3.7% in 2000, 2005, 2010 and 2014/15 respectively. Similarly, the study showed the higher proportion 11.6%, 31.2%, 14% and 3.8% of wasted children who had who recently had diarrhea before the survey than those at lower proportion of 8.2%, 21.3%, 9.8% and 4% in those who did not have recent diarrhea before the survey in respective and same years.

In addition, the results indicated that the higher proportion wasted children of 12.3%, 30.2% 13.8% were those who received low dietary diversity, respectively in 2000, 2005, 2010 than those who received acceptable diet 7.1%, 14.4%, 9.9% respectively in 2000, 2005, 2010 and 2,5% in 2014/15.

Similarly, the study revealed the higher proportion of wasted children 12.3% who received solid, semi-solid or soft foods and 6% of children who didn't receive solid, semi-solid or soft foods respectively in 2010 and 2014/15, than those of lower proportion of 6.5% and 6% who didn't receive and receive solid, semi-solid or soft foods in 2010 and 2014/15 respectively.

TABLE 3: BIVARIATE ANALYSIS OF WASTING AND SOCIO-DEMOGRAPHIC CHARACTERISTICS

Variables	2000				2005				2010				2014-15			
	% wasted	Total	chi2	p value	% wasted	Total	chi2	p value	% wasted	Total	chi2	p value	% wasted	Total	chi2	p value
Age (in months)																
0-5	5	802	23.402	0.000	3.1	451	23.3204	0.003	4.6	403	0.0345	0.899	5.3	397	5.5111	0.122
6-23	10.9	1,791			7.6	1,042			4.8	1,103			3.4	1059		
Total	9	2,592			6.2	1,493			4.8	1,507			3.9	1457		
Sex of child																
Male	10.7	1,332	9.0361	0.004	6.9	753	2.3411	0.280	6	739	9.1375	0.037	4.1	721	0.0996	0.836
Female	7.3	1,261			5.6	740			3.6	768			3.8	736		
Total	9	2,592			6.2	1,493			4.8	1,507			3.9	1,457		
Previous birth interval																
<24	8.7	424	0.137	0.931	4.8	269	4.3392	0.424	2.4	215	12.768	0.088	3.3	139	1.2289	0.804
24-47	9.3	1,300			6.5	761			5.3	622			4.1	529		
48+	8.9	416			4.4	201			7.2	234			4.7	412		
Total	9.1	2,140			5.7	1,232			5.1	1,070			4.2	1,079		
Child birth weight																
Overweight/obese	7.8	131	0.2564	0.907	5.2	90	1.2838	0.852	3.2	223	2.9108	0.551	2.4	221	4.1944	0.378
Normal	9	491			6.6	352			4.9	865			4.3	1,082		
Low weight	9.6	39			5	15			3.9	63			5.3	78		
Total	8.8	661			6.3	457			4.6	1,151			4	1,380		
Type of place of residence																
Urban	7.4	380	1.4933	0.248	5.9	196	0.0872	0.835	5.7	174	0.7013	0.544	3	251	1.5688	0.364
Rural	9.3	2,212			6.3	1,297			4.6	1,333			4.1	1,206		
Total	9	2,592			6.2	1,493			4.8	1,507			3.9	1,457		
Mother's BMI																
No education	9	844	5.8864	0.088	6.6	397	0.3141	0.934	3.4	270	2.7857	0.475	5	173	1.2891	0.746
Primary	9.8	1,461			6.1	778			5.1	1,097			3.8	1,065		
Secondary or higher	5.3	287			6.2	318			5.1	139			3.8	219		
Total	9	2,592			6.2	1,493			4.8	1,507			3.9	1,457		

Wealth index																
Rich					5.8	531	4.2938	0.388	4	513	15.046	0.019	3	505	6.9979	0.211
Middle					5	314			2.5	295			5.6	277		
Poor					7.2	648			6.3	699			4	675		
Total					6.2	1,493			4.8	1,507			3.9	1,457		
Source of drinking water																
Improved	8.2	988	1.42	0.260	5.9	579	0.5227	0.662	6.1	525	6.4516	0.213	4	595	0.0198	0.926
Not Improved	9.6	1,602			6.5	914			4.1	981			3.9	861		
Total	9	2,590			6.2	1,493			4.8	1,507			3.9	1,456		
Toilet type																
Improved toilet not shared	9.1	2,129	3.4886	0.204	5.6	1,229	11.4922	0.097	4.6	862	2.3916	0.538	3.6	770	16.624	0.034
Improved toilet but shared	7.2	361			9.9	194			3.7	228			1.6	248		
Unimproved toilet	13.6	80			8	57			5.6	415			5.8	439		
Total	9	2,570			6.3	1,480			4.8	1,505			3.9	1,457		
Early breastfeeding																
Immediately or within first hour	23.3	1,175	0.4598	0.819	6.1	1,014	0.941	0.783	4.1	1,085	7.5349	0.298	3.9	1,169	22.908	0.006
One hours or more	24.6	696			6.3	316			6.2	341			2.6	238		
One day or more	24	703			7.4	161			7.2	74			13	46		
Total	23.8	2,575			6.3	1,491			4.7	1,505			4	1,453		
Husband/partner's educational attainment																
No education	9.4	796	1.5747	0.599	28.8	387	24.9936	0.006	14.6	256	14.451	0.084	6.4	203	9.8695	0.218
Primary or lower	8.7	1,386			22.6	878			10.1	968			3.7	936		
Secondary	9.4	294			16.8	146			10	126			2.4	127		
Tertiary	2.6	24			6.3	11			0	21			2.4	35		
Total	9	2,499			23.6	1,422			10.8	1,370			3.9	1,301		
Mother's BMI																
Underweight	18.3	130	17.241	0.001	37	68	26.4401	0.025	24.9	68	46.286	0.000	10.4	65	23.365	0.02
Normal	9.5	1,856			24.6	1,114			11.1	1,075			3.7	964		
Overweight	5.3	254			15.7	123			4.9	185			1.8	217		
Obese	5.5	30			11.3	10			3.8	25			2.2	51		
Total	9.5	2,269			24.3	1,315			10.8	1,353			3.7	1,297		

Had diarrhea recently																
No	8.2	1,916	7.0425	0.017	21.3	1,179	28.3658	0.001	9.8	1,201	8.8146	0.038	4	1,186	0.0601	0.871
Yes	11.6	674			31.2	314			14	306			3.8	271		
Total	9	2,590			23.4	1,493			10.7	1,507			3.9	1,457		
Minimum dietary diversity																
Acceptable diet	7.1	1,621	19.708	0.000	14.4	644	106.61	0.000	9.9	1,208	7.4404	0.059	4.4	1,118	4.9069	0.147
Low dietary diversity	12.3	971			30.2	849			13.8	298			2.5	339		
Total	9	2,592			23.4	1,493			10.7	1,507			3.9	1,457		
Water treatment																
Not Treated									33	1,208	3.2602	0.216	30.8	850	0.711	0.561
Water treated									36.9	298			29.4	607		
Total									33.8	1,507			30.2	1,457		
Introduction of solid, semi-solid or soft foods																
No									6.5	423	21.231	0.001	6	430	14.33	0.014
Yes									12.3	1,084			3.1	1,027		
Total									10.7	1,507			3.9	1,457		
Distance to drinking water																
In the compound	9.2	2,341	0.6259	0.000	22.9	1,326	2.787	0.286	4.7	1,368	0.3018	0.715	4	1,316	0.6315	0.607
Less than 30 min	7.7	252			27	166			5.4	139			3.1	141		
Total	9	2,592			23.4	1,493			4.8	1,507			3.9	1,457		
Sex of head of household																
Male	3.9	1,171	0.2152	0.763	21.9	1,224	16.2309	0.016	4.3	1,197	6.1735	0.095	3.9	1,171	0.2152	0.763
Female	4.3	286			29.9	269			6.7	310			4.3	286		
Total	3.9	1,457			23.4	1,493			4.8	1,507			3.9	1,457		
Exclusively breastfed children																
Yes									4.6	1,177	0.5636	0.616	3.5	1,110	4.7374	0.148
No									5.3	330			5.3	347		
Total									4.8	1,507			3.9	1,457		

3.4. Bivariate analysis of Underweight and socio-demographic characteristics

As shown in Table 4, the study showed the higher proportion of underweight children who's the age varied between 6 to 23 months 33%, 31.4%, 12.3% and 9.6% in 2000, 2005, 2010 and 2014/15 than those aged 0 to 6 months who's the proportion was 3.3%, 4.9%, 6.2% and 4.7% in respective years. In addition, the study revealed the higher proportion of underweight children 14.1%, and 9.8% were boys than girls who's the proportion was 7.4% and 6.7% all in 2010 and 2014/15 respectively.

Furthermore, the study disclosed the higher proportion of underweight children was 39.2%, 50.8%, 23.3% and 24.5% of children with low birth weight at birth (<2.5Kg) in 2000, 2005, 2010 and 2014/15 than children born with normal birth weight at birth 15.2%, 17.6%, 10% and 7.7% respectively in the above years. Also, the study discovered that the higher proportion of underweight children 25.3%, 24.6%, 11.3% and 8.8% respectively in 2000, 2005, 2010 and 2014/15 were living in rural settings, than those who live in urban area who's the proportion was 15.5%, 15.1%, 6.1% and 5.9% in 2000, 2005, 2010 and 2014/15 respectively.

Similarly, the study showed the higher proportion of underweight children 27.7%,13.7% respectively in 2000 and 2010 were born to mothers with no education than those born to mothers with secondary education who's the proportion was 12.8%, 0.9% in 2000 and 2010. Likewise, the results indicated the higher proportion of underweight children in poor households of 28.5%, 13.5% and 11.3% in 2005, 2010 and 2014/15, noticing that data on wealth index data for 2000 were not available. Additionally, the study revealed the higher proportion of underweight children of 26.3%, 24.2%, 10.7% and 9.7% in households using not improved source of drinking water.

As well, the study revealed that the higher proportion of underweight children 27.9% and 15.4% were living in the households where husbands/partners were not educated respectively in 2000, and 2014/15, than those who were living in the households with secondary educated husbands/partners at 14.9% and 8.2% respectively in 2000 and 2014/15. In addition, the study revealed the higher proportion of underweight children 32.3%, 24.9% and 23% born to underweight mothers, than those 26.1%, 11.1% and 9.1% born to mothers with normal nutritional status respectively in 2000, 2010 and 2014/15.

Moreover, the study showed the higher proportion of underweight children 32.5% and 14% who had recent diarrhea prior to the survey, than those 20.9% and 9.8% who did not have recent diarrhea before the survey, respectively in 2000 and 2010.

Furthermore, the study showed the higher proportion of underweight children of 12.2% in 2000 and 2014/15 living in households headed by female, than those living in households headed by males and who's the proportion is 7.3% in the same above-mentioned years.

Still, the study showed that the higher proportion of underweight children was 11.8% in 2010 and 9.2% in 2014/15 of children who were exclusively breastfed, than those who were not exclusively breastfed 6.6% and 5.1% in 2010 and 2014/15.

TABLE 4: BIVARIATE ANALYSIS OF UNDERWEIGHT AND SOCIO-DEMOGRAPHIC CHARACTERISTICS

Variables	2000				2005				2010				2014-15			
	% underweight	Total	chi2	p value	% underweight	Total	chi2	p value	% underweight	Total	chi2	p value	% underweight	Total	chi2	p value
Age (in months)																
0-5	3.3	802	270.2	0.000	4.9	451	257	0.000	6.2	403	22.8	0.001	4.7	397	18.518	0.003
6-23	33.1	1,790			31.4	1,042			12.3	1,103			9.6	1059		
Total	23.9	2,592			23.4	1,493			10.7	1,507			8.3	1457		
Sex of child																
Male	25.5	1,331	4.286	0.062	24.5	753	2.24	0.330	14.1	739	35.3	0.000	9.8	721	9.6537	0.042
Female	22.1	1,260			22.2	740			7.4	768			6.7	736		
Total	23.9	2,592			23.4	1,493			10.7	1,507			8.3	1,457		
Previous birth interval																
<24	25.9	423	0.885	0.688	21	269	9.79	0.154	7.3	215	18.9	0.022	4.3	139	8.0716	0.211
24-47	24.3	1,300			23.6	761			14.6	622			8.7	529		
48+	23.1	416			29	201			12.1	234			8.9	412		
Total	24.4	2,140			23.9	1,232			12.6	1,070			8.2	1,079		
Child weight at birth																
Overweight/obese	10.5	131	22.62	0.000	8.5	90	77.6	0.000	6.4	223	35.6	0.001	4.7	221	67.165	0.001
Normal	15.2	491			17.6	352			10	865			7.7	1,082		
Low weight	39.2	39			50.8	15			23.3	63			24.5	78		
Total	15.7	660			16.9	457			10.1	1,151			8.1	1,380		
Type of place of residence																
Urban	15.5	380	17.19	0.000	15.1	196	18.1	0.001	6.1	174	8.51	0.019	5.9	251	4.7563	0.127
Rural	25.3	2,212			24.6	1,297			11.3	1,333			8.8	1,206		
Total	23.9	2,592			23.4	1,493			10.7	1,507			8.3	1,457		
Mother's education level																
No education	27.7	844	26.19	0.000	27.2	397	9.86	0.134	13.7	270	33.6	0.000	10.7	173	3.8924	0.421
Primary	23.8	1,461			22.4	778			11.2	1,097			8.1	1,065		
Secondary or Higher	12.8	287			20.9	318			0.9	139			7	219		
Total	23.9	2,592			23.4	1,493			10.7	1,507			8.3	1,457		

Wealth index																
Rich					17	531	45.1	0.000	6	513	36.5	0.000	4.5	505	36.503	0.001
Middle					23.7	314			12.1	295			7.8	277		
Poor					28.5	648			13.5	699			11.3	675		
Total					23.4	1,493			10.7	1,507			8.3	1,457		
Source of drinking water																
Improved	19.8	987	14.15	0.002	22	579	2.05	0.351	10.6	525	0.27		6.1	595	12.508	0.030
Not Improved	26.3	1,602			24.2	914			10.7	982			9.7	861		
Total	23.8	2,589			23.4	1,493			10.7	1,507			8.3	1,456		
Toilet type																
Improved toilet not shared	24.2	2,129	6.862	0.056	22.9	1,229	5.36	0.303	9.5	862	26.3	0.002	7.5	770	11.725	0.070
Improved toilet but shared	20.5	361			23.6	194			7	228			6.2	248		
Unimproved toilet	34	80			32.1	57			15.1	415			10.8	439		
Total	24	2,569			23.3	1,480			10.7	1,505			8.3	1,457		
Early Breastfeeding																
Immediately or within first hour	24.2	2,129	6.862	0.056	22.5	1,014	2.95	0.545	8.8	1,085	29.1	0.002	7.7	1,169	11.164	0.078
One hour or more	20.5	361			25.3	316			14.3	341			9.8	238		
One day or more	34	80			25.3	161			18.8	79			16.5	46		
Total	24	2,569			23.4	1,491			10.6	1,505			8.3	1,453		
Husband/partner's educational level																
No education	27.9	796	21.67	0.001	8	387	11.1	0.173	14.6	256	14.5	0.084	15.4	203	47.364	0.001
Primary or lower	23.9	1,386			6.1	878			10.1	968			6.2	936		
Secondary	14.9	294			2.7	146			10	126			8.2	127		
Tertiary	12.6	24			8.1	11			0	21			1.8	35		
Total	24	2,499			6.3	1,422			10.8	1,370			7.7	1,301		
Mother's BMI																
Underweight	32.3	130	29.95	0.00	12.1	68	13.9	0.11	24.9	68	46.3	0.000	23	65	54.955	0.001
Normal	26.1	1,856			6.1	1,114			11.1	1,075			9.1	964		
Overweight	13.4	254			3.2	123			4.9	185			3.5	217		
Obese	4.4	30			9.5	10			3.8	25			5.5	51		
Total	24.8	2,269			6.1	1,315			10.8	1,353			8.7	1,297		

Had diarrhea recently																
No	20.9	1,916	36.99	0.000	6.1	1,179	0.71	0.562	9.8	1,201	8.81	0.038	7.5	1,186	8.9002	0.061
Yes	32.5	673			7	314			14	306			11.4	271		
Total	23.9	2,589			6.2	1,493			10.7	1,507			8.3	1,457		
Child minimum dietary diversity																
Acceptable diet	20	1,620	35.38	0.000	4.6	644	10.8	10.816	9.9	1,208	7.44	0.059	8.2	1,118	0.1258	0.807
Low dietary diversity	30.3	971			7.5	849			13.8	298			8.6	339		
Total	23.9	2,592			6.2	1,493			10.7	1,507			8.3	1,457		
Water treatment																
Not Treated									12.3	755	8.45	0.051	9.4	850	7.5338	0.06
Water treated									9	752			6.6	607		
Total									10.7	1,507			8.3	1,457		
Introduction of solid, semi solid or soft foods																
No									16.2	423	163	0.000	6.7	430	3.8809	0.192
Yes									40.7	1,084			8.9	1,027		
Total									33.8	1,507			8.3	1,457		
Distance to drinking water																
In the compound	24.2	2,340	1.965	0.176	6.2	1,326	0.01	0.959	10.5	1,368	0.72	0.559	8.1	1,316	0.5276	0.635
Less than 30 min	20.3	252			6.3	166			12.2	139			9.4	141		
Total	23.9	2,592			6.2	1,493			10.7	1,507			8.3	1,457		
Sex of head of household																
Male	7.3	1,171	14.93	0.008	5.8	1,224	5.65	0.126	10.6	1,197	0.11	0.807	7.3	1,171	14.928	0.008
Female	12.2	286			8.5	269			11	310			12.2	286		
Total	8.3	1,457			6.2	1,493			10.7	1,507			8.3	1,457		
Exclusively breastfed children																
Yes									11.8	1,177	14.7	0.007	9.2	1,110	12.272	0.022
No									6.6	330			5.1	347		
Total									10.7	1,507			8.3	1,457		

3.5. Multivariate analysis of Stunting with socio-demographic characteristics among < 2 years children in Rwanda DHS 2000, 2005, 2010 and 2014/15, full model

According to the Table 5, children of age from 6 to 23 months old were found to be twelve times more likely to be stunted compared to those with 0 to 5 months old OR=12.1505 (CI=5.467-27.001), *p* value = 0.000 in 2000, 6.6 times more to be stunted compared to those with 0 to 5 months old in 2005, OR= 6.673 (CI=2.844 – 15.654), *p* value = 0,000 in 2005; 3.5 times at risk of being stunted compared to those with 0 to 5 months old in 2010 OR=3.538 (CI=2.353 – 5.318), *p* value=0,000) and 4.4 times more to be stunted compared to those with 0 to 5 months old OR=4.443 (CI=2.824 – 6.991), *p* value= 0.001) in 2015. Similarly, the results revealed that being male were 1.8 times more to be stunted OR=1.837 (CI= 1.385 – 2.436, p value=0.001) in 2010 and the same in 2015 OR=2.156 (CI=1.617363 – 2.874), *p* value = 0.001), compared to female children. In addition, the results showed that children from households of 7 persons or more were 1.5 times more at risk of being stunted OR=1.500 (CI=1.004 - 2.242), p value= 0.048, compared to those with 1 – 3 persons in 2010. Moreover, in 2005 children from rural area were 2 times more likely to be stunted OR=1.935 (CI=1.121 – 3.340), *p* value=0.018, compared to those living in urban area. Furthermore, children with lower birth weight were 3.5 times more likely to be stunted OR= 3.541 (CI=1.323 – 9.479), *p* value= 0.01 in 2000; 5.2 times more likely to be stunted OR= 5.280 (CI=1.553 – 17.951), *p* value = 0.008, in 2005; and 2.9 times more likely to be stunted OR=2.947931 (CI=1.490 –5.831), *p* value=0.002) in 2010 while in 2015, children were 5 times more likely to be stunted OR=5.059 (CI=2.583 - 9.908), p value=0.001. Also, children whose mothers were educated at secondary and higher level, were 2.3 times more likely to be stunted OR=2.354 (CI=1.1902 - 4.658), p value = 0.01) in 2000. Lastly, children from poor households were 2 times more likely to be stunted in 2010 OR= 2.066 (CI=1.429 – 2.988), p value = 0.001 in 2010 while in 2015, they were 1.5 times more likely to be stunted OR=1.535 (CI=1.063 – 2.216), *p* value =0.022) in 2015, all compared to those who from rich household

TABLE 5: MULTIVARIATE ANALYSIS OF STUNTING WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA, 2000, 2005, 2010 AND 2014/15, FULL MODEL

Variables	2000				2005				2010				2014/15			
	Odd Ratio	[95% C.I]		*p* value	Odd Ratio	[95% C.I]		*p* value	Odd Ratio	[95% C.I]		*p* value	Odd Ratio	[95% C.I]		*p* value
Age_child (in months)																
0-6	1				1				1				1			
7-23	12.150	5.467	27.001	0.000	6.673	2.844	15.654	0.000	3.538	2.353	5.318	0.000	4.443	2.824	6.991	0.001
Sex_child																
Female	1				1				1				1			
Male	1.000	0.655	1.526	0.998	1.313	0.858	2.008	0.207	1.837	1.385	2.436	0.000	2.156	1.617	2.874	0.001
Household size																
1 to 3 persons	1				1				1				1			
4 to 6 persons	0.893	0.492	1.620	0.71	1.583	0.868	2.881	0.132	1.540	1.091	2.172	0.014	1.137	0.773	1.672	0.512
7 or More	0.700	0.348	1.406	0.315	1.522	0.766	3.022	0.229	1.501	1.004	2.242	0.048	1.119	0.696	1.797	0.641
Residence																
Urban	1				1				1				1			
Rural	1.486	0.846	2.608	0.167	1.935	1.121	3.340	0.018	1.336	0.766	2.330	0.306	1.059	0.706	1.589	0.78
Weight at birth																
Overweight	1				1				1				1			
normal	1.112	0.645	1.918	0.7	1.465	0.827	2.596	0.189	1.601	1.103	2.325	0.013	1.841	1.226	2.764	0.003
Low weight	3.541	1.323	9.479	0.01	5.280	1.553	17.951	0.008	2.947	1.490	5.831	0.002	5.059	2.583	9.908	0.001
Mother's education																
Secondary or higher	1				1				1				1			
Primary	1.455	0.864	2.449	0.16	0.706	0.410	1.216	0.21	2.003	1.068	3.757	0.03	1.353	0.873	2.095	0.175
No education	2.354	1.190	4.658	0.01	0.834	0.410	1.697	0.616	2.016	0.994	4.089	0.052	1.406	0.766	2.582	0.27
Wealth Index																
Richer					1				1				1			
Middle					1.347	0.713	2.542	0.356	1.960	1.255	3.060	0.003	1.085	0.707	1.666	0.706
Poor					1.185	0.675	2.080	0.552	2.066	1.429	2.988	0.000	1.535	1.063	2.216	0.022

Dietary diversity																
Acceptable min. diet	1				1				1				1			
Low diet	1.842	0.830	4.090	0.132	1.482	0.725	3.027	0.279	1.143	0.485	2.689	0.497	2.271	0.853	6.049	0.1
Water source																
Improved water source	1				1				1				1			
Not Improved	0.990	0.634	1.547	0.967	0.914	0.546	1.532	0.735	0.983	0.706	1.368	0.919	1.090	0.793	1.498	0.591
Mother's BMI																
Overweight									1				1			
Normal									1.311	0.860	1.999	0.206	1.285	0.903	1.827	0.162
Underweight									1.438	0.694	2.975	0.327	1.646	0.860	3.147	0.131
Had diarrhea																
No	1				1				1				1			
Yes, last two weeks	0.735	0.441	1.225	0.237	1.457	0.819	2.592	0.199	0.975	0.691	1.375	0.887	1.134	0.800	1.607	0.476

3.6. Multivariate analysis of Wasting with socio-demographic characteristics among < 2 years children in Rwanda DHS 2000, 2005, 2010 and 2014/15, full model

The Table 6, showed children aged 6 to 23 months old were 12 times more likely at risk to be wasted OR=12.005 (CI = 4.097 – 35.175), *p* value = 0.001) compared to those aged 0 to 5 months old in 2005.

Additionally, children with underweight at birth were 25 times more likely to be wasted OR= 25.79801 (CI=5.859 –113.586), *p* value= 0.000) in 2005. Additionally, children from poor households were 2.7 times more likely to be wasted OR= 2.777 (CI = 1.263 – 6.104), *p* value = 0.01), in 2005. Lastly, children born to underweight mothers were 4.7 times more likely at risk of being wasted OR=4.690 (CI =1.1424 - 19.254), *p* value= 0.032) and 5.4 times more to be wasted OR=5.415 (CI=1.476 - 19.860), p value = 0.011, compared to those who's the mothers were overweight, respectively in 2010, 2014/15.

TABLE 6: MULTIVARIATE ANALYSIS WASTING WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA DHS 2000, 2005, 2010 AND 2014/15, FULL MODEL

Variables	2000				2005				2010				2014/15			
	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value
Age_child (in months)																
0-5	1				1				1				1			
6-23	0.989	0.377	2.594	0.983	12.005	4.097	35.175	0.000	0.877	0.428	1.798	0.320	0.804	0.387	1.668	0.558
Sex_child																
Female	1				1				1				1			
Male	1.693	0.908	3.157	0.097	1.270	0.701	2.300	0.428	1.717	0.925	3.184	0.539	1.153	0.602	2.206	0.666
Household size																
1 to 3 persons	1				1				1				1			
4 to 6 persons	1.083	0.498	2.353	0.839	1.096	0.518	2.321	0.808	0.679	0.332	1.390	0.247	1.524	0.541	4.289	0.423
7 or More	0.626	0.277	1.416	0.26	1.483	0.643	3.421	0.354	1.009	0.439	2.321	0.427	3.034	0.969	9.498	0.056
Residence																
Urban	1				1				1				1			
Rural	1.275	0.696	2.338	0.429	1.196	0.568	2.517	0.635	0.571	0.227	1.434	0.267	0.829	0.314	2.187	0.705
Weight at birth																
Overweight	1				1				1				1			
Normal	1.103	0.510	2.387	0.801	2.789	1.110	7.006	0.029	1.256	0.508	3.105	0.62	1.475	0.549	3.963	0.44
Low weight	1.175	0.353	3.906	0.791	25.798	5.859	113.586	0.000	1.157	0.261	5.114	0.847	1.589	0.375	6.737	0.528
Education Secondary or higher	1				1				1				1			
Primary	2.180	0.937	5.072	0.07	0.932	0.419	2.070	0.862	1.114	0.427	2.901	0.825	0.692	0.303	1.577	0.38
No education	1.890	0.674	5.299	0.225	1.257	0.483	3.273	0.637	0.597	0.173	2.056	0.413	0.689	0.207	2.294	0.544

Wealth Index															
Richer					1				1				1		
Middle					3.626	1.653	7.951	0.001	0.628	0.163	2.408	0.429	1.523	0.580	3.999	0.391
Poor					2.777	1.263	6.104	0.011	3.108	1.371	7.048	1.294	1.332	0.508	3.490	0.558
Dietary diversity															
Low diet	1				1				1				1		
Acceptable min. diet	1.842	0.830	4.090	0.132	1.482	0.725	3.027	0.279	1.143	0.485	2.689	0.497	2.271	0.853	6.049	0.1
Water source															
Improved water source	1				1				1				1		
Not Improved	1.111	0.590	2.091	0.743	1.579	0.807	3.088	0.181	0.539	0.276	1.051	0.183	1.377	0.695	2.727	0.357
Mother's BMI															
Overweight									1				1		
Normal									1.854	0.704	4.878	0.21	1.905	0.712	5.095	0.198
Underweight									4.690	1.142	19.254	0.032	5.415	1.476	19.860	0.011
Had diarrhea															
No	1				1				1				1		
Yes, last two weeks	0.992	0.509	1.932	0.982	1.152	0.553	2.399	0.703	0.808	0.368	1.772	0.322	0.705	0.297	1.673	0.428

3.7. Multivariate analysis of Underweight with socio-demographic characteristics among < 2 years children in Rwanda DHS 2000, 2005, 2010 and 2014/15, full model

The Table 7 showed that children aged 6 to 23 months old were 9.7 times more likely at risk of being underweight compared to those with 0 to 5 months old OR=9.739 (CI = 3.725 – 25.461), *p* value = 0.000, in 2000. Likewise, male children increased 2.5 times more to be stunted OR=2.570 (CI=1.587 – 4.163), p value = 0.001 in 2010 while in 2015, they were 1.5 times more likely to be underweight OR=1.568 (CI=1.010 – 2.433), *p* value = 0.045, compared to female children, in 2015. Similarly, children who were living in households of 7 persons or more were 2.4 times more likely to be underweight OR = 2.425 (CI = 2.425 - 4.471), p value = 0.005 in 2010 compared to those living in households with 1-3 persons. In addition, children living in rural area were 1.9 times more likely to be underweight OR=1.970 (CI= 1.003 – 3.866), p value= 0.049 in 2000, compared to those living in urban area. Moreover, children who had low weight at birth were 6.8 times more likely to be underweight OR=6,866 (CI= 2.087 - 22.593), p value = 0002, in 2000, 5.5 times more likely to be underweight OR=5.502 (CI=2.132 – 14.200), p value = 0.001, in 2010 while in 2015 they were 6.5 times more likely to be underweight OR= 6.587 (CI = 2.642 – 16.202), p value= 0.000, compared to those with overweight at birth. The study also revealed that, children born to non – educated mothers were 3.8 times more likely to be underweight OR=3,884 (CI=1,600 - 9,427), p value= 0,003, in 2000 while in 2010, they were 9.4 times more likely to be underweight OR=9.417 (CI=1.886 – 47.000), p value=0.006, all compared to those born to mothers with secondary or higher education level. Furthermore, children who were living in poor households both were 2.2 times more to be underweight OR= 2.234 (CI= 1.213 – 4.113), p value = 0.01 in 2010, while in 2015, the same children were 2.5 times more likely to be underweight OR=2.596 (CI=1.279 – 5.267), *p* value = 0.01. Similarly, children from households which were using not improved water source were 1.8 times more likely to be underweight OR=1.801 (CI=1.060 – 3.060), p value =0.03) in 2015, compared to those living in households using improved water source. Additionally, children who's the mothers' nutritional status were underweight were 4.9 times more likely to be underweight OR= 4.908 (CI=1.702 - 14.148), p value=0.003 in 2010 while in 2015, they were 5.6 times more likely to be underweight, compared to those who's the mothers were overweight.

TABLE 7: MULTIVARIATE ANALYSIS OF UNDERWEIGHT WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA DHS 2000, 2005, 2010 AND 2014/15, FULL MODEL

Variable	2000				2005				2010				2014/15			
	Odd Ratio	[95% C.I]		*p* value	Odd Ratio	[95% Conf.	Interval]	*p* value	Odd Ratio	[95% C.I]		*p* value	Odd Ratio	[95% C.I]		*p* value
Age_child (in months)																
0 - 5	1				1				1				1			
6 - 23	9.739	3.725	25.461	0.01	3.138	0.852	11.547	0.085	1.350	0.745	2.443	0.32	1.697	0.910	3.165	0.1
Sex_child																
Female	1				1				1				1			
Male	1.673	0.976	2.867	0.061	1.454	0.588	3.577	0.417	2.570	1.587	4.163	0.01	1.568	1.010	2.433	0.05
Household size																
1 to 3 persons	1				1				1				1			
4 to 6 persons	1.140	0.592	2.194	0.693	1.072	0.363	3.167	0.898	1.322	0.758	2.305	0.323	1.155	0.629	2.121	0.64
7 or More	0.810	0.385	1.705	0.578	0.868	0.259	2.903	0.818	2.425	1.316	4.471	0.005	1.292	0.619	2.696	0.49
Residence																
Urban	1				1				1				1			
Rural	1.970	1.003	3.866	0.049	0.598	0.214	1.670	0.326	1.198	0.542	2.649	0.653	0.567	0.262	1.226	0.15
Weight at birth																
Overweight	1				1				1				1			
Normal	1.569	0.778	3.167	0.207	1.350	0.459	3.962	0.584	1.710	0.890	3.282	0.106	1.747	0.860	3.548	0.12
Low weight	6.866	2.087	22.593	0.002	1.113	0.085	14.534	0.935	5.502	2.132	14.200	0.001	6.587	2.642	16.42	0.001
Education																
Secondary or higher	1				1				1				1			
Primary	1.972	0.970	4.012	0.061	1.260	0.428	3.710	0.673	8.600	1.842	40.135	0.006	0.945	0.456	1.958	0.88
No education	3.884	1.600	9.427	0.003	1.026	0.291	3.620	0.967	9.417	1.886	47.000	0.006	0.772	0.308	1.935	0.58
Wealth Index																
Rich					1				1				1			
Middle					1.071	0.308	3.720	0.913	1.694	0.840	3.416	0.14	1.606	0.716	3.603	0.25
Poor					1.008	0.321	3.168	0.988	2.234	1.213	4.113	0.01	2.596	1.279	5.267	0.01

Dietary diversity																
Acceptable min. diet	1				1				1				1			
Low diet	1.483	0.761	2.891	0.246	2.015	0.770	5.271	0.152	1.432	0.835	2.456	0.191	1.169	0.670	2.038	0.58
Water source																
Improved water source	1				1				1				1			
Not Improved	1.417	0.801	2.507	0.23	1.091	0.423	2.816	0.856	1.013	0.631	1.627	0.955	1.801	1.060	3.060	0.03
Mother's BMI																
Overweight									1				1			
Normal									2.008	0.936	4.309	0.073	1.750	0.807	3.793	0.16
Underweight									4.908	1.702	14.148	0.003	5.648	2.190	14.563	0.01
Diarrhea																
No	1				1				1				1			
Yes, last two weeks	1.346	0.791	2.291	0.272	1.037	0.320	3.362	0.951	1.314	0.795	2.173	0.285	0.827	0.463	1.476	0.52

3.8. Multivariate analysis of Stunting with socio-demographic characteristics among < 2 years children in Rwanda using DHS 2000, 2005, 2010 and 2014/15, reduced model

The Table 8 showed that the age of the child (6 to 23 months) were 12 times more likely at risk of being stunted compared to those with 0 to 5 months old OR=11.999 (CI=6.062 – 23.752), *p* value = 0.001) in 2000, 6.2 times more to be stunted OR= 6.221 (CI=3.204 – 12.076), *p* value = 0.001) in 2005; 3.7 times more at risk of being stunted OR=3.765 (2.657 – 5.334), *p* value=0.001) in 2010 and 4.5 times more to be stunted OR= 4.596607 (CI=3.104 – 6.806), *p* value= 0.001) in 2015; all compared to those aged 0 to 5 months.

Similarly, the results revealed that the children who were living in rural area increased 1.7 times more the probability of being stunted OR=1.785 (CI=1.136 – 2.804), *p* value = 0.012) in 2005, compared to those living in urban area. In addition, the child sex (being male) increased 1.7 times more likely the probability for children to be stunted OR=1.754 (CI= 1.354 – 2.275), *p* value = 0.000) in 2010; while in 2015, they increased 2.1 times more likely to be stunted OR=2.156 (CI=1.663 – 2.878), *p* value = 0.001).

Furthermore, children born with low birth weight were 3.5 times more likely to be stunted OR= 3.526 (CI=1.315 - 9.451), *p* value=0.012) in 2000; 4.1 times more likely to be stunted OR=4.145 (CI= 1.197 - 14.347), *p* value=0.025 in 2005, 3.2 times more likely to be stunted OR=3.210 (CI= 1.677 - 6.141), *p* value=0.001 in 2010, and 4.7 times more likely to be stunted OR=4.700 (CI= 2.485 - 8.891), *p*=0.001) in 2015. Also, the Table 8 showed that children who were living in the households with 7 persons or more was 1.5 times more to be stunted OR=1.513 (CI=1.031 –2.220), *p*=0.034, in 2010. Moreover, children whose mothers were not educated, were 2.6 times more to be stunted OR=2.699 (CI=1.390 - 5.240), *p* = 0.003) in 2000, while in 2010, 2.6 times more likely to be stunted OR=2.601 (CI=1.368 - 4.943), *p* = 0.004), compared to those whose mothers were educated at secondary and higher level. Additionally, children from poor households are, respectively 2.6 times more likely to be stunted OR= 2.153 (CI=1.553 – 2.985), *p* = 0.001) and 1.9 times more likely to be stunted OR=1.984 (CI=1.488 – 2.647), *p* =0.001) respectively in 2010 and 2015, compared to those from rich households.

TABLE 8: MULTIVARIATE ANALYSIS OF STUNTING WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA DHS 2000, 2005, 2010 AND 2014/15, REDUCED MODEL

	2000				2005				2010				2014/15			
	Odds ratio	[95% CI]		p value	Odds ratio	[95% CI]		p value	Odds ratio	[95% CI]		p value	Odds ratio	95% CI]		p value
Age_child (in months)																
0-6	1				1											
7-23	11.999	6.062	23.752	0.001	6.221	3.2047	12.076	0.01	3.765	2.657	5.334	0.01	4.596	3.104	6.806	0.01
Sex_child																
Female									1				1			
Male									1.755	1.354	2.275	0.01	2.188	1.663	2.879	0.01
Residence																
Urban	1				1											
Rural	1.478	0.912	2.395	0.112	1.785	1.136	2.804	0.01								
Weight at birth																
Overweight	1				1				1				1			
normal	1.147	0.675	1.948	0.611	1.414	0.816	2.451	0.21	1.555	1.094	2.210	0.014	1.659	1.132	2.431	0.009
Low weight	3.526	1.315	9.451	0.012	4.145	1.197	14.347	0.02	3.210	1.677	6.141	0.001	4.700	2.485	8.891	0.001
Mother's education																
Second and higher	1								1							
Primary	1.586	0.989	2.544	0.055					2.254	1.269	4.005	0.006				
No education	2.699	1.390	5.240	0.003					2.601	1.368	4.943	0.004				
Wealth Index																
Richer									1				1			
Middle									1.896	1.271	2.828	0.002	1.352	0.951	1.923	0.092
Poor									2.153	1.553	2.985	0.001	1.984	1.488	2.647	0.001
Household size																
1 to 3 persons									1							
4 to 6 persons									1.449	1.045	2.009	0.026				
7 or More									1.513	1.031	2.220	0.034				
Recent diarrhea																
No	1				1											
Yes	0.037	0.014	0.093	0.001	0.196	0.055	0.691	0.01	0.168	0.040	0.710	0.001	0.032	0.018	0.056	0.001

3.9. Multivariate analysis of Wasting with socio-demographic characteristics among < 2 years children in Rwanda DHS 2000, 2005, 2010 and 2014/15, reduced model

The Table 9 showed that the children aged 6 to 23 months was 8.5 times more likely at risk of being wasted compared to those with 0 to 5 months old OR=8.551 (CI= 3.405 – 21.475), p value=0.000) in 2005 and 1.8 times more at risk of being wasted compared to those with 0 to 5 months old OR= 1.859 (CI=1.102 – 3.136), *p* value = 0.02) in 2010.

Similarly, the child sex (being male) increased 1.5 times more likely at risk to be wasted than females OR=1.537 (CI=1.146 – 2.061), *p* value=0.004) in 2000. In addition, the study revealed that children who received the minimum acceptable diet were 1.9 times likely at risk to be wasted OR=1.965 (CI=1.467-2.633) and 1.8 time more likely to be wasted OR=1.859 (CI=1.102 -7.202) respectively in 2000 and 2015, compared to those who received low diet.

Also, children whose mothers were educated at secondary and higher level, were 2.2 times more likely to be wasted OR=2.261 (CI=1.201 - 4.255), *p* = 0.012) in 2000, compared to those whose mothers were not educated. Moreover, children with lower birth weight were 24 times more likely to be wasted OR= 24.762 (CI=6.188 - 99.090), p value=0.001) in 2005, compared to those who were born with low birth weight in 2000. Moreover, the study showed that children from poor households were 3.5 times more likely to be wasted OR=3.539 (CI=1.917 – 6.534), p value=0.001 in 2005 and 2 times more likely at risk of being wasted OR= 2.055 (CI= 1.917 - 6.534), p value=0.016 in 2015, compared to those from rich households.

Besides, children born from mothers with normal weight were 3.3 times more likely to be wasted OR=3.378 (CI=1.038 - 10.992), p value= 0.043 in 2010 and 5.7 times more likely to be wasted OR=5.754 (CI=1.690 -19.594), *p* value=0.005) in 2015; compared to those who's the mothers were underweight in both years. Lastly, the study showed that children from households using not improved water were 0.5 time more likely to be wasted OR=0.530 (CI=0.299 - 0.940), p value=0.03), compared to those who were living in families using improved water, in 2010.

TABLE 9: MULTIVARIATE ANALYSIS OF WASTING WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA DHS 2000, 2005, 2010 AND 2014/15, REDUCED MODEL

Variables	2000				2005				2010				2014/15			
	Odd Ratio	[95% C.I]		P value	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value
Age_child (in months)																
0 - 5					1				1							
6 - 23					8.551	3.405	21.475	0.001	1.859	1.102	3.136	0.02				
Sex_child																
Female	1															
Male	1.537	1.146	2.061	0.004												
Dietary diversity																
Min Acceptable diet	1												1			
Low diet	1.965	1.467	2.633	0.01									2.701	1.013	7.202	0.05
Education																
Secondary and higher																
Primary	2.251	1.222	4.146	0.009												
No education	2.261	1.201	4.255	0.012												
Weight at birth																
Overweight					1											
Normal					2.752	1.130	6.702	0.03								
Low weight					24.763	6.188	99.090	0.01								
Mother's nut status																
Overweight									1				1			
Normal									1.227	0.569	2.645	0.6	1.890	0.705	5.061	0.21
Underweight									3.378	1.038	10.992	0.04	5.754	1.690	19.594	0.01
Water source																
Improved water									1							
Not improved									0.530	0.299	0.940	0.03				
Wealth Index																
Richer					1				1							
Middle					3.785	1.797	7.972	0.01	0.812	0.338	1.949	0.64				
Poor					3.539	1.917	6.534	0.01	2.055	1.144	3.688	0.02				

3.10. Multivariate analysis of Underweight with socio-demographic characteristics among < 2 years children in Rwanda, DHS 2000, 2005, 2010 and 2014/15, reduced model

The Table 8 showed that the age of the child (6 to 23 months) were 12 times more likely of being underweight OR=12.681 (CI=5.421 - 29.662), *p* value=0.001) in 2000; 2.6 times more likely to be underweight OR=2.616 (CI=1.370 - 4.993), p value=0.004) in 2005; 4.5 times more likely to be underweight OR=4.596 (CI=3.104 - 6.806), p value=0.001 in 2015, all compared to those aged 0 to 5 months old. Also, the child sex (being male) increased 1.7 times more likely to be underweight OR= 1.778967 (CI= 1.030 - 3.071), p value= 0.039) in 2000; 2.6 times more likely to be stunted OR=2. 283 (CI= 1.624 - 4.253), p value=0.001 in 2010, while in 2015, male children were 2.1 times more likely to be underweight OR=2.188 (CI= 4.253 - 2.878), p value=0.000; compared to their counterpart females.

In addition, the residence (rural area) increased 1.9 times more likely to be underweight OR= 1.970 (CI= 1.003 - 3.866), p value=0.049) in 2000; compared to those living in urban area. Furthermore, children born with lower birth weight were 7.2 times more likely to be underweight OR=7.292 (CI=2.161-24.611), *p* value=0.001 in 2000, 6 times more likely to be underweight OR=6.073, CI= 2.439 -15.119), *p* value=0.001 in 2010, while in 2015 they were 5.5 times more likely to be underweight OR= 5.598 (CI= 2.948 - 10.627), *p* value=0.001; compared to those born with normal weight. Moreover, the results revealed that children whose mothers were educated at secondary and higher level were 3.7 times more likely to be underweight OR=3.743 (CI= 1.549 - 0.645), *p*=0.004 in 2000, compared to those whose mothers were not educated.

Also, the results showed that in 2010, children the households size of 7 or more persons were 2.2 times less likely of being underweight OR= 2.24085 (CI= 1.219 - 4.118), p=0.009 only in 2010. Similarly, the study showed that children from poor households were, respectively 2.8 times more likely of being underweight OR=2.831 (CI= 1.605 - 4.99), p=0.001 and 1.9 times more likely to be underweight OR=1,984 (CI = 1.488 - 2.647), p=0.001) respectively in 2010 and 2015; compared to those living in rich households. Lastly, children born from mothers with normal weight were 6.4 times more likely at risk of being underweight OR=6.467 (CI= (2.536 -16.491), p value=0.026 in 2010; compared to those born from underweight mothers.

TABLE 10: MULTIVARIATE ANALYSIS OF UNDERWEIGHT WITH SOCIO-DEMOGRAPHIC CHARACTERISTICS AMONG < 2 YEARS CHILDREN IN RWANDA, IN 2000, 2005, 2010 AND 2014/15, REDUCED MODEL

	2000				2005				2010				2015			
	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		P value	Odd Ratio	[95% C.I]		p value	Odd Ratio	[95% C.I]		p value
Age_child (in months)																
0 - 6	1				1								1			
6 - 23	12.681	5.421	29.662	0.001	2.616	1.370	4.993	0.004					4.596	3.104	6.806	0.01
Sex_child																
Female	1								1				1			
Male	1.778	1.030	3.071	0.039					2.628	1.624	4.253	0.001	2.188	1.663	2.878	0.01
Residence																
Urban	1															
Rural	1.970	1.003	3.866	0.049												
Household size																
1 to 3 persons									1							
4 to 6 persons									1.267	0.726	2.213	0.403				
7or more									2.240	1.219	4.118	0.009				
Weight at birth																
Overweight	1								1				1			
Normal	1.675	0.829	3.381	0.149					1.634	0.803	3.322	0.174	1.809	1.235	2.650	0.01
Low weight	7.292	2.161	24.611	0.001					6.073	2.439	15.119	0.001	5.598	2.948	10.627	0.00
Wealth index																
Rich									1				1			
Middle									2.045	1.035	4.041	0.039	1.352	0.951	1.923	0.09
Poor									2.831	1.605	4.994	0.001	1.984	1.488	2.647	0.01

Education									
Secondary and higher	1								
Primary	2.08081	1.037	4.174	0.039					
No education	3.74384	1.549	9.047	0.004					
Mother's BMI									
Overweight						1			
Normal						1.871	0.866	4.042	0.11
Underweight						6.467	2.536	16.491	0.01

Summary of factors associated with malnutrition among children under two years

As shown in Table 11, the factors that were significantly associated with stunting in children < 2 years include child's age and birth weight all in 2000, 2005, 2010 and 2015, while sex (being male) and wealth index (living in poor household) were identified as significantly associated factors with stunting only in 2010 and 2015. In addition, mother's education (no education) was significantly associated with stunting in 2000 and 2010, whereas residence (living in rural area) and the household size (4 to 6 persons) were also significantly associated with stunting in children respectively in 2005 and 2010. Furthermore, the study revealed significant association of the child's age in 2005, 2010 while sex, (being male) and wealth index (being poor) were identified as significantly associated factors with stunting only in 2005 and 2010.

Moreover, the dietary diversity was significantly associated with wasting in 2000 and 2015. In addition, mother's nutritional status was significantly associated with wasting in 2010 and 2015. Also, the education (no education) and sex (being male) were significantly associated with wasting, while birth weight and water source (use of not improved drinking water) was significantly associated with wasting only in 2010.

Additionally, Table 11 showed that factors such as the child's age, child's birth weight was significantly associated with underweight in children < 2 years, in 2000, 2005 and 2015 while with sex (being male) the study revealed the same association specifically in 2000, 2010 and 2015. Similarly, the wealth index (living in poor household) were identified as significantly associated factors with underweight only in 2010 and 2015. In addition, mother's nutritional status (being underweight) and household size (4 to 6 persons) were identified as significantly associated with the child's underweight respectively in 2010 while mother's education (no education) and residence (child living in rural area) were similarly associated with children underweight in 2000.

Thus, the factors associated with (malnutrition (stunting, wasting and underweight) are mainly:

- child age (6-23 months old),
- low birth weight (<2.500kg)
- sex (males are more affected)
- wealth index (children from poor households are at risk)
- education (children born to non - educated mothers)

- Mother malnutrition (children born to underweight mothers are more affected)
- Low dietary diversity (children receiving low dietary diversity are more affected)
- Residence (children from rural areas are more exposed)
- Household size (children from households with 7 persons or more)
- Water source (children from households no improved water source).

TABLE 11: SUMMARIZED HIERARCHICAL FACTORS ASSOCIATED WITH MALNUTRITION AMONG UNDER TWO YEARS CHILDREN

Variables	2000			DHS 2005			DHS 2010			DHS 2015/14		
	Stunting	**Wasting**	**Underweight**	**Stunting**	**Wasting**	**Underweight**	**Stunting**	**Wasting**	**Underweight**	**Stunting**	**Wasting**	**Underweight**
Age (6-23 months)	Associated		Associated	Associated	Associated	Associated	Associated	Associated		Associated		Associated
Birth weight (low birth weight)	Associated		Associated	Associated	Associated		Associated		Associated	Associated		Associated
Sex (male)		Associated	Associated				Associated		Associated	Associated		Associated
Wealth index (poor)					Associated		Associated	Associated	Associated	Associated		Associated
Education level (no education)	Associated	Associated	Associated				Associated					
Mother's nutritional status								Associated	Associated		Associated	
Dietary diversity		Associated									Associated	
Residence (rural)	Associated		Associated	Associated								
Household size (7 persons or more)							Associated		Associated			
Water source											Associated	

CHAPTER IV. DISCUSSION

4.1. Prevalence of malnutrition in Rwanda

According to RDHS 2015, nationally, 38 percent of children under age 5 are stunted. Stunting was predominant (49 percent) among children age 18-23 months. Stunting by sex was (43 percent among boys and 33 percent among girls). Stunting was more prevalent among children born very small (61 percent). Forty-nine percent of children born to undernourished mothers (BMI below 18.5 kg/m2) were stunted. The percentage of rural children was predominantly stunted (41 percent). The prevalence of stunted children was higher among children living in the poorest households (49 percent) and among children whose mothers have no education (47 percent).

Two percent of children under age 5 were wasted. Wasting is about four times as common among children born to malnourished mothers. Stunting prevalence was higher (11 percent) in urban areas. The survey showed nine percent of children under age 5 who were underweight. The percentage of children who were underweight increased to 11 percent among those age 12-17 months. Being underweight was more prevalent among children born very small (22 percent). Rural children are almost twice as likely to be underweight (10 percent), while predominant those were born to mothers in the lowest wealth quintile. Also, the higher prevalence of underweight children born to undernourished mothers were underweight (25 percent versus 10 percent).

4.2. Factors associated with malnutrition among children under two years in Rwanda

Based on the study findings, the child age was an associated factor with malnutrition among children aged 6-23 months, especially with child stunting at 42.7%, 46.9%, 40.6%, 37.2% respectively in 2000, 2005, 2010 and 2015 while it was an associated factor to child underweight at 33.1%, 31.4% and 9.6% respectively in 2000, 2005 and 2015. This seems that there was an issue around the timely and adequate introduction of complementary foods. This study has found a strong positive association between low birth weight (LBW) and malnutrition among children under age two years in Rwanda. For example, the risk of being underweight during the early years of childhood was found to be 39.2%, 50.8%, 23.3% and 24.5% higher in children with LBW than in children with normal birth weight, respectively in 2000, 2005, 2010 and 2015; even after controlling other factors in a multivariable model. Thus, it appears that babies who are underweight at birth tend to remain underweight during their early childhood. The observed association between

birth weight and malnutrition is consistent with the findings of other studies which indicate that mothers who are underweight are more likely to produce preterm births, which can result in stunting, incomplete growth and development, or death (36).

The study revealed that child sex variable for 2005, 2010 and 2015 and wealth index variable for 2010 and 2015, were found to be associated factors with wasting and underweight. Male children may have early exposure to early inappropriate weaning practices and complimentary feeding especially in low-income households. Malnutrition (stunting, wasting and underweight) was higher in boys than girls(14). A similar study on "factors associated with malnutrition among children < 5 years in Burkina Faso", showed that males were significantly more likely to be underweight, stunted and wasted than females. Consistent with the previous results, boys were more likely to become underweight, stunted and wasted than girls in children under 5 years in Ethiopia. Additionally, 10 sub-Saharan African countries reported that boys under 5 years were more likely to become stunted than girls under 5 years (37). Similar other preceding studies, our study showed significant relationship between mother's education and child malnutrition where the mother's education is an important determinant in child health, where children born to mothers who did not access to education were at risk of being stunted, wasted and underweight in 2000. This may be due to that an educated mother has more opportunities to be informed and aware of health care, better nutrition, child development compared to an uneducated mother.

This study has shown that households' poverty was also associated factors of stunting, wasting and underweight in 2010 and 2015. Poverty in a household is one of causes of households' food insecurity and this could lead to nutrients and calories low intake, inaccessibility to primary care (lack of health care insurance), childhood illness, less expenditures for complementary foods, as well as other factors that are observed in low income households and which all contribute to the child's malnutrition. This was supported by other studies which revealed that children in the poorest households were two times more likely to be wasted (20.6%) compared to children in the wealthiest households (10.3%)(14). Impoverished households are less likely to have sufficient access to the resources necessary to ensure children's health (38). Also, this study showed that mothers' nutritional status was associated with wasting and underweight in their children which lead to stunting a result of early and long-term malnutrition. The 2013 Nigeria DHS reported children whose mothers are thin (BMI less than 18.5) have the highest levels of stunting (48

percent), while those whose mothers are overweight or obese (BMI of 25 or above) have the lowest levels (25 percent). This study has also shown that the low dietary diversity as an associated factor wasting among the children in the study in 2000 and 2015. Evidence from 11 Demographic and Health Surveys confirmed that dietary diversity is generally associated with child nutritional status, and that the associations remain when household wealth and welfare factors are controlled for by multivariate analyses. From the results of this study, it has been revealed that household size (7 persons and more) was identified as an associated factor with stunting and underweight in 2010. This finding could be associated by the households' poverty and therefore, lead to insufficient meals due to insufficient finance.

Another study conducted in Ile-Ife, Nigeria, revealed the association of family size, household food security status and child care practices with the nutritional status of under-five children. The prevalence of malnutrition as measured by stunting was higher (39.3%) than that reported by the Demographic Health Survey in 1986 in Ondo State, Southwest Nigeria (32.4%); it was close to the 40.6% measured in the 2008 DHS survey12 by the Federal Office of Statistics (43%); and it was lower than UNICEF's estimate of 52.3% for 1994. The prevalence of wasting (6.3%) and being underweight (14.1%) was lower in any case (41). Lastly, our study found a significant association between the source of water and the children's wasting, in which families that use unimproved water as source. The use of unsafe drinking water can lead to increased cases of infections and then of diarrhea, loss of nutrients and cause acute malnutrition therefore and wasting. A study conducted in Baghdad City, Iraq reported an association between the source of drinking water and child malnutrition was significant (p=0.034) with prevalence odds ratio of 2.414. The effect of diarrhea on children's nutritional status is very important and until now is considered the major cause of child malnutrition (39).

Limitation of the study

Qualitative aspects of data were not included in this study to explore associated factors and strengthen the findings of the quantitative study. In addition, the study did not analyze all variables related to child malnutrition that were included in the DHSs datasets, to find more factors that may influence child malnutrition. Moreover, there were some variables that were missing especially in the DHS 2000 and 2005 such as wealth index, introduction to solid, semi solid or soft foods. The comparison of these above-mentioned variables with other DHSs was not possible.

Conclusion and recommendations

Conclusion

The specific objective of this study was to identify associated factors with malnutrition among under two years children in Rwanda and compare risks factors associated with malnutrition among under two years children in Rwanda, such as social-demographic, environmental and feeding practices factors, using secondary data analysis of the Rwanda Demographic and Health Survey 2000, 2005, 2010 and 2014/2015. This study found a high level of stunting, wasting and underweight among children between 6 months and 23 months with underlying factors which include socio economic, feeding practices and environmental. However, socio-economic factors were found to be the predominant factors of child malnutrition. Children who had low weight at birth were found mostly at risk of being stunted and underweight in the four years of our study. Male children were predominantly stunted and underweight that their counterparts' females particularly in 2010 and 2015. Children born in poor households were exposed to be stunted, wasted and underweight mostly in 2010. Mother's education had significant relationship with child malnutrition. Children born to non-educated mothers were more exposed of being stunted in 2000. The high prevalence of stunting found in this study enable us to conclude that stunting is still an important public health problem, especially among children under 2 years in Rwanda. The study also, revealed series of socio-demographic factors, environmental factors and feeding practices significantly associated with malnutrition among under two years.

Recommendations

Based on the main findings of this study, we suggest the following recommendations:

- Improve couple functionality for better communication and decision making around the use of household resources, to improve food security and resilience for children under two years and pregnant and lactating women nutrition.
- Strengthening the economic and food security especially of the poor households through increased production and purchase power etc.
- Impowering women through primary, secondary education and non-formal skill training to improve economic independence and IYCF knowledge. However, there should be a continuous follow-up to ensure that the acquired knowledge is put into practice.

- Strengthen nutritional and health outcomes messaging aiming at popularizing better locally available nutritious foods, supplementary feeding programs for children under two through all entry points of child care.
- Encourage the involvement of the private sector as an increasingly large player in areas related to child nutrition and potential contributor to improve it.
- Strongly address community social influences, cultural norms, that negatively affect the Maternal and Infant and Young Child Nutrition (MYCN).
- Continue strengthening the multi-sectoral coordination of nutrition interventions at all levels.
- Increase safe and supportive environments for optimal nutrition for adolescent girls and pregnant women and lactating mothers of lower socioeconomic status, as they are more likely to have poorer pregnancy nutrition and therefore low nutritional status that can contribute to low birth weight of the child.
- Continue mobilizing both parents (wife and husband) to improve birth spacing, using family planning methods to address large family size issue and accordingly, household food insecurity within the family.
- Strengthen an effective implementation of key the effectiveness and cost-effectiveness of preventive strategies to address infectious diseases such as diarrhea, through behavior change and public health education, water source supply and sanitation improvements to promote personal and domestic and food hygiene

Further Research

Bearing in mind the Catholic Relief Services (CRS) findings on "Father engagement in nutrition" qualitative analysis in Muhanga and Karongi districts in Rwanda, the authors highlighted the potential promise of dialogue-based approaches to male involvement in nutrition, there is a need for further research to better understand:

- *"How can more transformative thinking around gender and familial responsibilities for child nutrition be encouraged?"*

- *"The associated determinants with stunting differentials of sex in different contexts in Rwanda".*

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ANNEX: DHS Program authorization letter

Aug 03, 2018

Odette Uwera Kamanzi
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Request Date: 08/03/2018

Dear Odette Uwera Kamanzi:

This is to confirm that you are approved to use the following SPA Datasets for your registered research paper titled: "Factors associated with stunting among children under 2 year":

Rwanda

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area(Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the

coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use thedata for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. Users are required to submit an electronic copy(pdf) of any reports/publications resulting from using the DHS data files to: archive@dhsprogram.com.

Sincerely,

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program