International Development

ISSN 1470-2320

Prizewinning Dissertation 2020

No.20-KA

The Haitian Nutritional Paradox: Driving factors of the Double Burden of Malnutrition

Khandys Agnant

Published: February 2020

Department of International Development

London School of Economics and Political Science

Houghton Street **Tel: +44 (020) 7955 7425/6252**

London **Fax: +44 (020) 7955-6844**

WC2A 2AE UK **Email: d.daley@lse.ac.uk**

Website: http://www.lse.ac.uk/internationalDevelopment/home.aspx

Candidate Number: 17752

MSc in Health and International Development 2019

Dissertation submitted in partial fulfilment of the requirements of the degree

The Haitian Nutritional Paradox: Driving factors of the Double Burden of Malnutrition

Word Count: 9,979

Abstract:

While Haiti was once said to be the exception to the nutritional transition and the DBM, available data has increasingly shown transitions in the population's dietary pattern, as more and more undernourished children coexist with overweight/obese mothers. Given this shift in Haitians diets, this study sought to assess the driving factors of the DBM within Haitian households. Using quantitative research methods to identify potential driving factors of the DBM [Overweight/Obese mothers paired with Stunted Children] in Haitian households, this study conducted a multinomial logistic regression. Based on available secondary data in the 2016-17 Haiti DHS, this study tested the association between the selected sociodemographic, maternal and childhood factors and household malnutrition in Haiti. Aligned with previous studies on the DBM in LMICs, this study demonstrated that the DBM in Haitian households is strongly associated with sociodemographic, maternal and childhood factors, specifically urbanisation, the number of infants in the household, maternal age and sex of the child.

Table of Contents

List of Abbreviations:

DBM	=	Double Burden of Malnutrition
HICs	=	High-Income Countries
LMICs	=	Low and Middle-Income Countries
NCDs	=	Non-Communicable Diseases
SD	=	Standard deviations
DALYS	=	Disability Adjusted Life Years
TFCs	=	Transnational Food Companies
NR-NCD	=	Nutrition-Related Non Communicable Disease
NR-CD	=	Nutrition-Related Communicable Disease
IHE	=	L'Institut haïtien de l'Enfance/ Haitian Institute of Childhood
IHSI	=	L'Institut haïtien de Statistiques et d'Informatiques/ Haitian Institute of Statistics and Informatics
HDI	=	Human Development Index
DHS	=	Demographic and Health Survey
CDs	=	Communicable Diseases

1. Introduction

While significant improvements in nutrition have been recorded globally in the past decades, the prevalence of undernutrition and the rise in the incidence of overnutrition has increasingly become a serious public health concern in LMICs (Popkin 2009; B. Kulkarni et al. 2014; Wise 2014; Abdullah 2015). Moreover, an increasing amount of literature has demonstrated that the populations of multiple LMICs have experienced various levels of transition within the overall structure of their dietary patterns (Popkin 1998, 2001, 2002). Moreover, modified patterns of the protracted-polarized model has increasingly been recorded across LMICs, since the mid 1990s (Kennedy et al. 2006). In such, rapid shifts in dietary patterns and lifestyles, including a series of demographic, social and economic changes, have enabled the global rise in obesity and NR-NCDs (James et al. 2004; West et al. 2012). As recent analysis of mortality and morbidity trends suggests, important increases in NR-NCDs in LMICs have disproportionately been identified amongst poor and marginalised populations, all the while contributing to widening health gaps between and within countries (Shetty 2016).

Notwithstanding the persistent problem of undernutrition in LMICs, available literature increasingly argues that the rise in the amount of evidence of overnutrition in LMICs shows a unique situation where cases of undernutrition and overnutrition coexist within the same population and in some instances the same household or even individual (West et al. 2012; Bates et al. 2017), hence the double burden of malnutrition (DBM). While the cause of the DBM is related to a series of changes occurring globally, such as the nutrition transition and demographic transition (Shrimptona and Rokx 2012), this phenomenon is now believed to exist in most LMICs (Popkin 2009; Cai 2014; Abdullah 2015). It is even demonstrated that this phenomenon has gradually reached superior rates than in high-income countries (HIC) (Doak et al. 2000; Popkin 2001, 2002; Monteiro et al. 2004). Exemplifying this is the 2017 report on global food security which demonstrated the rise of nutrition-related health issues in LMICs, as the global number of undernourished individuals had risen to 815 million, while 41 million in infants were indicated to be overnourished (FAO et al. 2017). Moreover, while it is important to note variations between regions, LMICs continue to be confronted with high levels of undernourishment, while registering a rapid rise in obesity and NR-NCDs, therefore being affected by a DBM at the population level (FAO et al. 2017; Mamun and Mascie-Taylor 2019). Amongst these countries is Haiti, which saw a 12% rise in obesity and a 5–8% decline in adult and child undernutrition over the last decade (ICF 2018). While Haiti and other countries of Central America were once said to be exceptions to the nutritional transition, as well as the

prevalence of the DBM due to their continuously high levels of undernutrition and NR-CDs (Popkin 2002; Omran 2001, 2005), new data is increasingly showing a rise in the incidence of the DBM within this region (ICF 2018). Moreover, the prevalence of DBM at the household level, where stunted children coexist with overweight/obese mothers, is increasingly commonly found in Latin American countries (Shrimptona and Rokx 2012) and potentially Haiti.

Given this, this study seeks to address the following research question:

- *What is driving the double burden of malnutrition (DBM) in Haitian households [Overweight mothers with stunted children]?*

Divided in 8 parts, the first sections of this dissertation will present a critical review of the available literature outlining the relevant transitioning theories and how Haiti fits within the literature. Subsequently, a conceptual framework will be presented, followed by the study's research question and hypothesis are explored. A methodological outline is then provided in section 6 to 7. Finally, the study will conclude with discussions regarding this study's findings and the conclusion.

2. Literature Review:

The purpose of the below literature review is to introduce the relevant transitioning theories that justified the selection of Haiti as a case study and also informed our conceptual framework. Additionally, evidence demonstrating how Haiti fits within the current literature is presented within this section.

2.1. Theoretical Considerations:

Referring to the changes in the composition of populations' diets, which is often accompanied by changes in the levels of physical activities, Popkin categorised the stages of the nutrition transition within 5 patterns (Popkin 2002). These patterns included the collection of food, famine, receding famine, nutrition-related chronic and degenerative disease, and behavioural change (Ibid.). Not bind to a specific historical period, country's dietary status within this theoretical framework is believed to vary based on their levels of urbanisation, socioeconomic development and modernisations (Ibid.). Therefore, focusing on the large shifts in dietary and activity patterns, the sequence of change linked to each stage of Popkin's (2002) theory is characterised by specific indicators, such as the type of energy intake[1]. However,

[1] See Figure 2, Appendix A

while Popkin's (2002) theory places emphasis on dietary and activity patterns, and trends in body composition of various populations within a broad societal perspective, to understand broader patterns, we must complement his theory with two additional historic processes of change. Moreover, often preceding or occurring simultaneously to the nutrition transition, interpretations of the demographic and epidemiological transition are important in the analysis of broader patterns, as health outcomes within each of these transitions often overlap (Popkin 2002)[2]. Studying mortality and fertility trends within a country, the demographic transition theory enables us to understand shifting patterns in which a society transitions from high fertility and mortality levels to progressively declining fertility and mortality trends, as these changes are often linked to industrialisation, as well as socioeconomic development (Ibid.). As for the epidemiological transition, this theory enables us to analyse the long-term leading causes of death and current health trends within a country, as it focuses on shifting disease patterns (Omran 1971, 2001, 2005; Popkin 2002). Amongst these patterns are shifts in the high prevalence of infectious diseases associated with malnutrition towards a high prevalence of chronic and degenerative diseases linked to urbanisation and industrialisation (Horiuchi 1999; Omran 1971, 2001, 2005; Popkin 2002). Overall, the combination of these theories enables us to understand underlying causes of changes in countries health outcomes.

2.2. Contextualising Haiti:

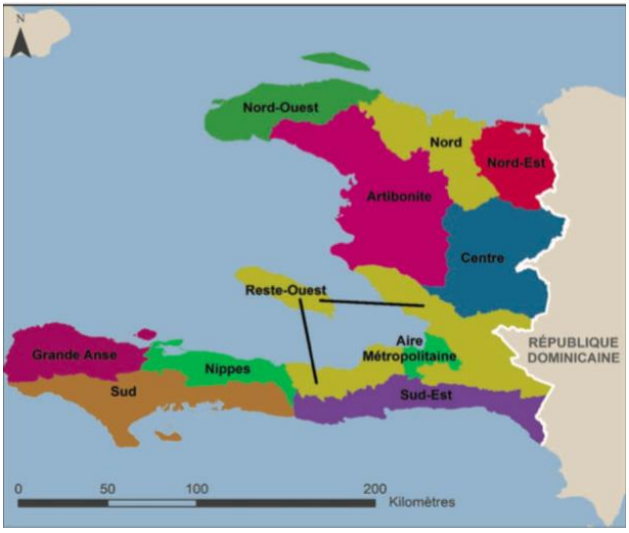

Figure 1: Haitian Provinces. Source: DHS VI Report, 2018

As Haiti continues to be one of the poorest countries in the western hemisphere, this country's socioeconomic development is now believed to have enabled the creation of a favourable environment for increases in the incidence of the DBM at the household level (Raphaël et al.2005). A nation with population of approximately 11 million, split across ten departments (ICF 2018) with a median age of 23 in 2017, Haiti was ranked 168 out of 188 countries on the 2018 HDI, all the while having a slow GDP growth of 0.3% between 2017 and 2018 (World Bank 2019). With a Gini coefficient of 0.59 in 2012, recent findings indicated that Haiti is also one of the most unequal countries in the region, with approximately 59% of its population under the poverty line and

[2] See Figure 3, Appendix A

24% below the extreme poverty line (ICF 2018). While important inequalities affect the whole of the Haitian population, further geographical inequalities are observed within the country. 70% of rural households were considered chronically poor in comparison to approximately 20% urban households (World Bank 2014). Accentuated by the important depreciation of the Haitian Gourde over the last decades, increases in living cost has marked Haitian household consumption of goods and exacerbated inequality levels within the country, particularly in rural areas (Ibid.).

2.3. Haiti's Demographic, Epidemiological and Nutrition Transition:

In the past Haiti was described as following the contemporary or delayed transition model of the epidemiological transition due to its moderate levels of declining mortality, high levels of fertility, all the while facing a dual burden of continuing prevalence of CDs and malnutrition, along with a rise in NCDs (Omran 1971, 2001, 2005; Kuate Defo 2014). However, nowadays, we are now able to observe within the Haitian state a demographic transition, as it slowly reaches the third stage (Bogentson 2011; CIA 2019). As Haitian life expectancy is slowly increasing (World Bank 2018b), and birth rates decline (World Bank 2018a), new health challenges related to both NCDs and CDs, are projected to rapidly rise within the country. Available data is increasingly demonstrating very high rates of diabetes, hypertension and heart diseases amongst Haiti's adult population. Moreover, focusing on the complex changes in health, disease and mortality patterns due to demographic, nutrition, economic and sociological changes (Kennedy et al. 2006; Shetty 2016), evidence of an epidemiological transition is also becoming increasingly apparent in Haiti, with NCDs, particularly NR-NCDs, progressively contributing to premature deaths and morbidity of amongst population (WHO 2018a, 2019a).

While various factors have been identified as driving the rise in NCDs amongst adults, it is the shifting pattern within the nutrition transition that is of particular interest. As Haitians gradually adopt diets high in total fat and other refined carbohydrates, and an increasingly sedentary lifestyle spread amongst its population, important increases in the prevalence of obesity are gradually going to be observed and will lead to the rise of chronic and degenerative diseases, as demonstrated in stage four of Popkin's (2002) theory. However, while the nutritional practice of the Haitian households has gradually shifted towards diets high in fat and refined carbohydrates, currently available data seem to indicate that Haiti is in between the third and fourth stage of the nutrition transition. Haiti's current status within the nutrition transition theory is due to undernourishment continuing to be a public health issue, while

excess adiposity is rapidly rising across the whole of the population, particularly amongst the female adult population (Raphaël et al. 2006; USAID 2018).

Additionally, while increasing data is demonstrating rising trends in obesity and NR-NCDs amongst Haitian adults, the same does not directly apply to Haitian children. Underweight, stunting and wasting persist and remain an important health concern amongst young populations. Consequently, being at greater risk of dying from various common infections (UNICEF 2019), nutrition-related diseases has remained highly ranked in DALYs amongst Haitian children (IHME 2019)[3]. Although the prevalence of wasting amongst children has been progressively decreasing, Haitians children vulnerability and nutritional risks remain high, as the prevalence of stunted infants was indicated to be above 20%, in the last decade (République d'Haïti et al. 2012; Irarrázaval et al. 2018; ICF 2018). Moreover, Haiti was recently described as having the highest prevalence of infant malnutrition in the Americas (Irarrázaval et al. 2018).

Overall, while Haiti has previously been described as exempt from the nutrition transition, new evidence suppose the opposite. Indeed, as more data demonstrating Haiti's rapid shift towards new stages of the epidemiological and demographic transition become available, it becomes increasingly relevant to study this country's nutritional profile.

3. Conceptual Framework:

While the DBM pose a new threat to existing health systems, as well as to the country's future economic growth and its population's well-being (Abdullah 2015), this phenomenon, as well as the variables associated with the nutrition transition in Haiti has unfortunately been continuously ignored (Raphaël, et al. 2005). This is mostly due to policies and programmes prioritising food security within their analysis rather than studying other determinants linked to nutritional outcomes (FAO et al. 2017).

Argued to be part of three of major problems of global health, which include: the unfinished agenda for the reduction of malnutrition and CDs, the growth of NR-NCDs in LMICs nations and issues related to globalisation (Hawkes 2006; Powell 2011), recent research on health and nutrition in LMICs has drawn attention to various interlinked driving factors of household malnutrition, particularly the DBM (Sarma et al. 2017). Used by a plethora of scholarships discussing the rise of obesity, childhood malnutrition and the DBM,

[3] See Figure 4 and Figure 5, Appendix B

sociodemographic, maternal and childhood characteristics have previously been demonstrated to be key underlying causes of the nutrition transition in LMICs and HICs.

3.1. Sociodemographic Factors of Household Malnutrition:

Social and demographic factors, including household place of residence (urban/rural), specifically urbanisation, household wealth and household size are documented to have an important effect on household nutrition. In the case of urbanisation, the rapid growth of urban populations has affected on the overall structure of individuals' diets and lifestyles (Drewnowski and Popkin 1997). Many researchers corroborated with Drewnowski and Popkin's (1997) article, demonstrating that trends in excess adiposity in urban settings have increasingly become a public health concern in both LMICs and HICs, as urban living was linked to wider variety of goods and diets composed of processed and highly saturated food (Powell 2011; Lim et al. 2016; B. Kulkarni 2018). However, while urbanisation was in many instances negatively associated with adult nutrition, in some context urban living positively affected childhood health, as the built environment was indicated to be more favourable to childhood development in comparison to rural living (Shrimptona and Rokx 2012).

As for household wealth, this sociodemographic characteristic was demonstrated to have profound effects on household diets. Previous scholarships examining the DBM demonstrated that socioeconomic patterning of nutritional levels, as well as variations in relative household wealth, negatively affected families dietary habits (Powell 2011; Luhar et al. 2018). Arguing that during a countries' economic progress, households become increasingly likely of transitioning towards a diet high in fat and carbohydrate whilst adopting sedentary lifestyles, Kulkarni et al. (2017) demonstrated that economic progress often led to excess in adiposity for some household members. Additionally while increased household wealth may cause higher levels of energy intake, household wealth inequality continues to be strongly associated with chronic malnutrition amongst infants (Hong et al. 2006; Sarma et al. 2017).

Finally, with regards to household size, recent studies demonstrated how family sizes and higher weekly per capita expenditures within a household will likely affect a household diet (Oddo et al. 2012; Sekiyama et al. 2015; Dang and Meenakshi 2017). Households with large family size (higher than 5), as well as multiple infants (0–59 months), were demonstrated to be more likely of having chronically malnourished children (Huynh et al. 2019).

3.2. Maternal Factors of Household Malnutrition:

Maternal characteristics including maternal education, age, occupation and marital status, are closely related to both mothers and children's nutritional health. In the case of education, households with educated mothers were previously argued to have better health outcomes, as increase in education were demonstrated to lead to better socioeconomic status, as well as dietary changes linked to increase nutritional knowledge (Popkin 1993; Sarma et al. 2017). Moreover, maternal education has been associated with child stunting, as malnourished children were demonstrated to be more commonly found in households where mothers had limited levels of education (Mistry et al. 2019). Regarding maternal age, this individual-level variable was also demonstrated to affect nutrition within a household, as a study on maternal and childhood nutrition conducted in Brazil, Guatemala, India, the Philippines, and South Africa indicated that both young and advanced maternal age negatively affected household nutrition (Fall et al. 2015). Moreover, children of mothers under the age of 19 in LMICs were indicated to be disadvantaged as of birth, while, advanced maternal age (35 and older) was demonstrated to increase mothers likelihood of obesity during and after pregnancy, as well as their susceptibility to NR-NCDs, such as diabetes and hypertension (Ibid.). As for maternal occupation, Rashad and Sharaf (2019), demonstrated that childhood malnourishment was associated with maternal employment and occupation, as these factors were indicated to potentially decrease levels of household childcare, consequently leading to poor nutritional status. Their findings aligned with Popkin and Solon's (1976) article, and Abbi et al.'s (1991) findings on the dual effects of maternal employment and occupation on childhood nutrition, as income, time and working status of mothers were indicated to significantly affect children's nutritional status, varying accordingly to mother's employment sector and activities. Rashad and Sharaf (2019) also demonstrated that a mother's current marital status affected their children malnourishment status, as the presence of a partner was indicated to increase parental time spent with children, as well as household income, leading to better nutrition and children's care.

3.3. Childhood Factors of Household Malnutrition:

Along with the above-mentioned factors, Rashad and Sharaf (2015) demonstrated that individual-level factors associated with children had an effect on childhood nutrition. Amongst these factors was children's sex. While there are variations across regions, children's sex was indicated to affect their level of malnutrition within studied households, as female children

were in some cases less likely to be extremely stunted than their male counterpart (Rashad and Sharaf 2015).

4. Research Question and Hypothesis:

As data on the Haitian population's nutritional status is increasingly becoming available, the aim of this study was to assess the driving factors of the DBM, as well as other identified types of household malnutrition, and developed a context-specific assessment that identifies the links between the various social, household and nutritional determinants underlying these various divergent trends. Specifically, based on the available data and the conceptual framework, this study tested whether the identified factors of household malnutrition affected the DBM within Haitian households. Informed by the previous literature on maternal and childhood malnutrition, as well as malnutrition at the population level, the above conceptual framework identifies common driving factors of DBM that could enable me to answer this study's research question. With this conceptual framework, this study tested the following hypothesis:

- The DBM within Haitian households is strongly associated with sociodemographic and maternal factors, including urbanisation, the number of infants per household, household wealth, as well as maternal age and potentially education.

5. Methodology:

For the purpose of this study, available secondary data developed by the DHS were used. While these datasets were not produced to study this phenomenon, these can nonetheless shed light on current driving factors of the DBM in Haiti and identify gaps to explore in further relevant studies. Therefore, this dissertation utilised quantitative research methods to answer the research question. The methodology employed in this study aimed to test whether there is sufficient evidence to assess the driving factors of the DBM at the household level, all the while studying driving factors of other types of household malnutrition, such as child stunting and excess in adiposity amongst mothers. Moreover, as a complex range of interacting factors can determine the nature, as well as affect the course of the DBM within the Haitian state, this study has aimed to identify crucial contributors to the nutrition transition at the household level in Haiti. The following section describes this study data analysis and is then followed by an overview of the selected variables. Finally, this section will be discussing the choice of statistical method used to analyse the significance of the selected variables as predictors of the various levels of household malnutrition in Haiti, particularly the DBM.

5.1. Data Source and Sample Characteristics

This analysis utilised data from the 2016-17 Haiti DHS, which was conducted from the 30th of November 2016 to April 2017 by The Haitian Institute of Childhood (IHE) in collaboration with the Haitian Institute of Statistics and Informatics (IHSI). While the DHS has a range of survey topics varying with country context, the 2016-17 survey characteristics covered 20 topics relevant to the Haitian context, which included anthropometric measures and household characteristics. Additionally, this survey employed a two-stage cluster sampling procedure in order to ensure that the sample was representative of the urban and rural population, as well as the Haitian population as a whole (ICF 2018). Sampling weights were also made available in the Haiti DHS datasets and only required the researcher to divide this variable by 1,000,000 (Croft et al. 2018). The survey's sampling frame was based on the 2003 census with partial updates from 2011 provided by the IHSI. As part of their sample, the DHS selected 13,546 Haitian households and successfully interviewed 13,405 households (ICF 2018).

5.2. Study Population:

This study analysed content from the Haiti DHS children recode file, which collected information on all children under the age of 5 and mothers between the age of 15 and 49. Based on information gathered in the Woman's Questionnaire, such as children's and mother's anthropometric measures, as well as household sociodemographic characteristics, this dataset had one record for each infant of interviewed women (ICF 2017).

5.3. Outcome

Utilising anthropometric measures collected for the 2016–2017 Haiti DHS, to identify households with the relevant types of malnutrition, this study focused on households in which either overweight/obese mothers or stunted children can be found, if not both at the same time. These households were then compared to households with both normal weight mothers and non-stunted children. While initially this study aimed to conduct a multivariable logistic regression in which a binary dependent variable identifying households with both overweight/obese mothers and stunted children were categorised as 1 and all other households were categorised as 0, a different statistical method was utilised due to important variability in the dataset.

In the 2016-17 survey, the height and weight of children, as well as women were measured to determine their nutritional status, including their body mass index (BMI). While BMI measures may vary between race, to make the interpretation of our results more

comparable on a global scale, this dissertation used meaningful qualitative cut-offs from the WHO (WHO 2018, 2019). The rationale behind this decision was that the usage of the WHO's BMI cut-offs would enable this study to compare its findings with those of other LMICs and to capture general excess in adiposity amongst the studied population (Luhar et al. 2018; WHO 2018b, 2019b). Therefore, for the purpose of this study mothers that were overweight/obese were categorised as having a BMI over 24.99 kg/m2 (≥25.0) whereas normal weight mothers were categorised as having a BMI between 18.5 and 24.99 kg/m2. As for Haitian children's nutritional profile, this study utilised measures relating to their height for age. Moreover, since BMI measures are rarely used to measure children's nutritional health, this study also utilised the WHO Child growth standards to identify households, with either moderately or severely stunted children under the age of 5 (0 to 59 months)[4]. In this study, severely and moderately stunted children were categorised as height-for-age Z-score (HAZ) being 2 or 3 standard deviations below the mean on the WHO Child Growth Standards (WHO 2007a, 2007b).

For the purpose of this study, all possible mother – child combinations relevant to the DBM, to the exception of underweight mothers with stunted or non-stunted children, were included in this analysis. Underweight mothers with stunted or non-stunted children were excluded from our analysis due to the small size of this sub-population within the sample[5]. Only respondents with anthropometric information both for them and their children were included in this analysis, thus excluding pregnant and postpartum women. Children and women with missing information for any of the selected independent variables below were also excluded from this study. Out of 13,405 households, 6530 children under the age of 5 were identified and included in the DHS recode file. The dataset was then recoded in R, in order to conduct a household level analysis. First, we created a variable to identify the total number of children by households, then we identified how many children were stunted. We then identified whether there were overweight or obese mothers, and finally, we created a variable describing the situation in each household. Instead of having a row per child, we collapsed the information to have a description of the family and not each individual. As part of this process no cases

[4] The rationale behind this study's focus on childhood stunting rather than other indicators of childhood malnutrition such as underweight and wasting was that the former is a sign of chronic malnutrition. Moreover, the height-age-age variable enables this study to identify chronic nutritional deficiency amongst Haitian households (WHO 2015), whilst wasting may be strongly affected by illness and underweight does not differentiate between stunting and wasting amongst children (Garrett and Ruel 2003).

[5] Based on the recoded 2016-17 dataset approximately 248 mothers of children under the age of 5 are indicated to be underweight – BMI <18.5 – which represented nearly 5% of the remaining interviewed households within the dataset. Furthermore, since the aim of this dissertation is to assess the driving factors of the DBM, I decided to limit our analysis to variables that preclude to this phenomenon.

were deleted, as duplicate cases were not a problem in this logic. After recoding the Haiti DHS dataset, a total of 5005 cases remained. Finally, 3282 mother-child pairs were selected for our analysis based on the following criteria:

i) Normal weight mothers with non-stunted children (**Baseline**);
ii) Normal weight mothers with stunted children (**Studied Outcome 1**);
iii) Overweight mothers with normal weight children (**Studied Outcome 2**)
iv) DBM: Overweight mothers and stunted children (**Studied Outcome 3**).

5.4. Explanatory Variables[6]:

5.4.1. Sociodemographic Factors:

In light of literature on sociodemographic factors of household malnutrition, this group included available information on household wealth, type of place of residence and the number of infants in the household. Constructed as part of the DHS, the wealth index used in this study was changed from its original form in order to be recoded in three categories, ranging from low to high levels of household wealth. This variable was initially constructed on the basis of household ownership of selected assets, housing construction material, household WASH facilities, all the while adjusting their calculation based on variations between urban and rural areas (Rutstein and Kiersten 2004; Rutstein 2008; ICF 2019b). In the case of the second selected factor, type of place of residence, this variable was kept in its original form, which was as either urban or rural. Finally, the third driving factor – number of children under the age of 5 – was kept as continuous, in order to see whether the addition of a child in a household would affect the household health outcomes.

5.4.2. Maternal Factors:

Regarding maternal characteristics, maternal education, occupation, age and marital status were selected as potential driving factors of household malnutrition, particularly the DBM. Divided in four categories, the first maternal factor, maternal education, categorised mothers educational level as either no education (0 years), primary (1–5 years), secondary (6–12 years) or higher (12+ years). Regarding maternal occupation, this variable was recoded for this study. Moreover, whilst the Haiti DHS dataset coded mothers occupation in 12 categories[7] these were recoded in 4 – *Unemployed/Unclassified*, *domestic labour/Self-employed*, *service*

[6] See Table 3, Appendix C
[7] Based on the DHS original data, mothers occupation were grouped as follow – Not working, professional/technical/managerial, clerical, sales, Agricultural - self-employed, agricultural – employee, household and domestic, services, skilled manual, unskilled manual, other, don't know.

sector and manual labour. Maternal age was another selected predictor of household malnutrition that was recoded. Within this variable, mother's age was grouped within 3 ordinal categories based on maternal age a 10–11 year grouping rather than a 5 grouping – *15–24; 25–34; 35–45*. Lastly, mothers marital status was categorise in 3 groups, either *never in a union; married or living with their partner; and widowed, divorced or separated*.

5.4.3. Childhood Factors

The last selected potential driving factor of the DBM was the sex of the child, which was either male or female.

5.5. Ethical Standards

This analysis of driving factors of the DBM was conducted using publicly available data from the DHS. Consistent with the standards in ensuring the protection of respondents privacy, the collected data used in the present study was anonymous and acquired participants informed consent (ICF 2019a). Therefore, no additional ethical permission was required.

5.6. Analytical Strategy:

Seeking to discover the driving factors of the DBM based on the available data collected for the Haiti DHS, all the while exploring driving factors of other types of household malnutrition in Haiti, a multinomial logistic regression was performed to examine the effects of various measurement variables on the studied outcomes. The IBM SPSS 25 software was used for this study's data analysis, and the significance cut-off was $p < 0.05$.

5.6.1. Modelling Approach

As demonstrated by the conceptual framework, societies' nutrition transition and particularly the DBM is driven by multiple overlapping variables. Therefore, this study constructed statistical models that were sensitive to the interplay between different covariates. Moreover, four iterations of the model were added in order to isolate the effects of the above identified factors of household malnutrition. The first iteration included sociodemographic factors that may affect household malnutrition in Haiti, whereas the second iteration only included the selected maternal factors. As for the third model, sociodemographic factors were paired with maternal factors. Finally, childhood factors were added to model 4, in addition to sociodemographic and maternal factors. The rationale behind this modelling approach was to determine the individual effects of sociodemographic factors and maternal agencies on household malnutrition, as well as to assess whether the relationship between these driving factors and household malnutrition became stronger when paired.

6. Findings:

6.1. Prevalence of Household Malnutrition:

Table 1: Household Malnutrition in Haiti

Household Malnutrition

	Frequency	Percent
Normal weight mothers with non-stunted children	1605	48.9
Normal weight mothers with at least 1 stunted child	530	16.1
Overweight mothers with non-stunted children	997	30.4
DBM: Overweight mothers with at least 1 stunted child	150	4.6
Total	3282	100.0

Based on the recoded dataset, the most common type of household malnutrition identified, was having overweight or obese mothers paired with non-stunted children, representing 30% of the studied Haitian households. As for the other types of household malnutrition, specifically households with stunted children, this analysis demonstrated that Haitian households with normal weight mothers paired with stunted children represented 16% of the sample whereas Haitian households with a DBM represented 4.6% of the studied population. Moreover, based on the above table, it is possible to see that households with normal weight mothers were nearly four times more likely of having stunted children than households with overweight or obese mothers.

6.2. Multinomial Logistic Regression[8]:

Divided in three subsections, the results from the multinomial logistic regression compared each outcome categories, with the reference category – households with normal weight mothers and non-stunted children, based on the same four iterative models.

6.2.1. Normal Weight Mothers with Stunted Children[9]:

When looking at the first studied outcome, it is possible to see that in model 1, 3 and 4 two out of the three selected sociodemographic explanatory variables were indicated to significantly predict the likelihood of households with normal weight mothers to be paired with stunted children ($p < 0.001$). The first statistically significant variable was the number of infants in the studied Haitian households. Moreover, demonstrating a positive relationship between this predictor and the first studied outcome, households with more than one child under the age

[8] Note that the tables presented both here and in the appendix D outlines the comparison of each of the outcome category with the baseline category, based on the same 4 models.
[9] See Table 4, Appendix D

of five were 60–61% more likely of caring for stunted infants. As for the second sociodemographic predictor, this analysis demonstrated that the lower the household wealth, the higher the likelihood of finding a stunted infant within a Haitian household with normal weight mothers, in comparison to higher-income households, with changes in odds of 2.587–2.612 within the lowest wealth group and 2.230–2.244 amongst the middle wealth group. While the sociodemographic factor the type of place of residence was demonstrated to negatively affect childhood stunting in households with normal weight mothers in model 1 ($p < 0.001$), it's important to note that this relationship was indicated not to be statistically significant when adjusting the model to include maternal and childhood factors ($p > 0.05$).

Regarding predictors grouped under maternal factors, only mothers marital status, specifically whether mothers were married or living with their partner, was indicated to significantly predict the likelihood of having stunted children paired with normal weight mothers in all three models (models 2, 3 and 4) ($p < 0.05$ and $p < 0.001$). In model 2, where solely maternal factors were assessed, it was possible to see that the odds of childhood stunting were of 2.022. In models 3 and 4, mothers that were married or living with their partner were nearly 68% more likely of having stunted children, as opposed to widowed, divorced or separated mothers. As for all the other maternal predictors included in this analysis, these were demonstrated not to be statistically significant in every model, for the exception of maternal education in model 2 which indicated that mothers without an education were more likely of having stunted children, with change in odds of 2.538. Finally, the analysis of the first studied outcome demonstrated that when childhood driving factors such as the sex of a child, were added to sociodemographic and maternal factors, this predictor was statistically significant, as odds of childhood stunting within households with normal weight mothers were 45% higher than the odds of a household with no malnutrition when the child was of the male ($p < 0.001$).

6.2.2. Households With Overweight/Obese Mothers and Non-Stunted Children[10]:

When identifying potential driving factors of excess in adiposity in Haitian households with non-stunted children, this analysis demonstrated that all three sociodemographic predictors were statistically significant, except in model 1 ($p < 0.05$ and $p < 0.001$). In the case of the first sociodemographic factor of excess in adiposity in mothers – *the number of children under 5 five in the household* – this analysis indicated a negative relationship between this predictor and the studied outcome in models 3 and 4. Moreover, this relationship demonstrated

[10] See Table 5, Appendix D

that when adjusting the model to include maternal and childhood factors, it was nearly 12% less likely for mothers of non-stunted children to be overweight or obese when more than one infant was found in the household ($p < 0.05$). As for the second sociodemographic predictor – *the type of place of residence* – the analysis of models 3 and 4 demonstrated that when accounting for maternal and childhood factors, urban households in Haiti were nearly 92% more likely of having an overweight or obese mother paired with a non-stunted child than rural households ($p < 0.001$) whereas in model 1, where solely sociodemographic factors were included, it was nearly 85% more likely for urban mothers to be overweight or obese. Lastly, household wealth was demonstrated to have a negative association with the studied outcome, as mother's odds of being overweight or obese were 41–53% lower amongst the lower and middle wealth groups in comparison to households with higher levels of wealth. In short, the analysis of sociodemographic factors of household malnutrition seems to indicate that small urban households with higher levels of wealth and non-stunted children are more likely to have overweight or obese mothers. As for other potential driving factors of overweight and obesity in mothers of non-stunted children, this analysis revealed that maternal age, marital status and education were statistically significant predictors ($p < 0.05$, $p < 0.01$ and $p < 0001$). Moreover, the maternal age predictor in all three models 2, 3 and 4 indicated that mother's odds of being overweight or obese were 63 to 66% lower when mothers were between the age of 15–24 ($p < 0.001$) and between 23 and 27% lower when these were between the age of 25–34 ($p < 0.05$ and $p < 0.01$), when compared to mothers above the age of 35. Regarding mothers educational levels, models 3 and 4 revealed that non-educated mothers of non-stunted children were 41% less likely of being overweight or obese, in comparison to mother with a higher education, whilst being nearly 76% less likely in model 2 ($p < 0.001$). Model 2 also revealed that whilst it is less likely for mothers of non-stunted children to be overweight or obese, the percentage decreased as the mother's education increased. Therefore, it was 52.9% less likely for mothers with a primary education to be overweight or obese, and 42.9% for mothers with a secondary education ($p < 0.001$). Finally, when compared to widowed, divorced or separated mothers of non-stunted children, the analysis of the marital status predictor in models 3 and 4 demonstrated a bidirectional relationship in which it was 40% less likely for mothers that were never in a union to be overweight or obese ($p < 0.05$), while it was 50% more likely for mothers that were either married or living with their partner to be affected by higher BMI levels.

6.2.3. Household With Overweight Mothers and Stunted Children–DBM:

Lastly, with regards to the studied Haitian households with overweight mothers and stunted children (DBM), one out of the three selected sociodemographic factors were demonstrated to be statistically significant in every model and an additional sociodemographic predictor was indicated to be statistically significant in two out of the three models. The first statistically significant predictor was the number of infants living in the household ($p < 0.001$). Moreover, this analysis revealed that the number of children under the age of five in a household increased by 78 to 80% the odds of observing a DBM within a Haitian household. The second statistically significant sociodemographic factor in two out of the three models (models 3 and 4) was the type of place of residence ($p < 0.05$). When adjusting the model to include maternal and childhood factors, urban households were indicated to be 51% more likely of being affected by a DBM, as opposed to rural households. While the results for this outcome category demonstrated that household wealth was positively associated with the DBM, unlike in the two previously studied outcome, this factor was not statistically significant ($p > 0.05$). As for the maternal and childhood factors related to the DBM, this analysis revealed that mother's age and children's sex were indicated to significantly predict whether a Haitian household would have a DBM ($p < 0.05$) in models in which sociodemographic factors were included in the regression (models 3 and 4). Moreover, when compared to households with mothers above the age of 35, maternal age indicated a negative relationship in which it was 50% less likely for mothers between the age of 15 and 24 to be affected by the DBM, in comparison to mothers above the age of 35. Finally, regarding childhood factors, this analysis demonstrated that the sex of a child is once again positively associated with household malnutrition, specifically childhood stunting, as the odds of observing a DBM within a Haitian household were 41% higher when infants were of the male sex rather than of the female sex.

Table 2: Multinomial logistic regression results – Driving factors of the DBM in Haiti

DBM: Overweight/Obese Mothers with Stunted Children								
	M1		**M2**		**M3**		**M4**	
	B		B		B		B	
(Intercept)	-3.647***		-2.742**		-3.970***		-4.147***	
Predictors	*Estimates*	*CI*	*Estimates*	*CI*	*Estimates*	*CI*	*Estimates*	*CI*
Sociodemographic Variables								
Type of place of Residence *(Ref. Rural)*								
Urban	1.326	0.927 - 1.897			1.532*	1.035 - 2.268	1.518*	1.025 - 2.249
Household Wealth *(Ref. Higher)*								
Low	1.308	0.871 - 1.965			1.207	0.769 - 1.895	1.215	0.774 - 1.910
Middle	1.573	0.973 - 2.544			1.465	0.891 - 2.408	1.478	0.899 - 2.430
Number of 0–59 Month Children								
	1.782***	1.517 - 2.094			1.780***	1.508 -2.101	1.797***	1.521 - 2.122
Maternal Variables								
Age								
15–24			0.880	0.314 - 0.933	0.506*	0.291 - 0.880	0.496*	0.285 - 0.863
25–34			1.593	0.746 - 1.699	1.050	0.692 - 1.593	1.047	0.690 - 1.590
Current Marital Status *(Ref. Widowed, Divorced or Separated)*								
Never in Union			0.446	0.118 - 1.684	0.437	0.115 - 1.658	0.436	0.115 - 1.657
Married or Living with Partner			1.800	0.876 - 3.696	1.624	0.783 - 3.369	1.639	0.789 - 3.403
Highest Educational Level *(Ref. Higher)*								
No Education			1.522	0.485 - 4.775	1.515	0.451 - 5.093	1.482	0.440 - 4.989
Primary			1.761	0.581 - 5.336	1.691	0.534 - 5.358	1.653	0.521 - 5.246
Secondary			1.260	0.414 - 3.833	1.237	0.399 - 3.829	1.205	0.389 - 3.738
Occupation *(Ref. Manual Labour)*								
Unemployed/Unclassified			0.603	0.196 - 1.850	0.647	0.206 - 2.026	0.648	0.206 - 2.036
Domestic Labour/Self-Employed			0.472	0.139 - 1.610	0.528	0.152 - 1.835	0.522	0.150 - 1.820
Service Sector			0.744	0.249 - 2.224	0.863	0.283 - 2.632	0.866	0.284 - 2.646
Childhood Variables								
Sex of Child *(Ref. Female)*								
Male							1.418*	1.007 - 1.997
The reference category is: Normal Weight Mothers with Non-Stunted.								
Note: * p <0.05 **p <001 *** p <0.001. All models are based on 3282 household observations.								

All in all, accounting for approximately 20% of variance in the dependent variable data, based on the pseudo-R^2, models 3 and 4 suggests that the selected sociodemographic and maternal factors are strong predictors of the DBM, as well as other types of household malnutrition in Haiti[11]. Therefore, while other explanatory factors of this phenomenon exist, it is worthwhile noting that, at this time, the gathered evidence partly support this study's hypothesis – that the DBM is significantly associated with sociodemographic and maternal factors, such as urbanisation, number of infants in the household, and maternal age. Moreover, while the only strong sociodemographic predictor of the DBM is the number of infants in the household when maternal and childhood factors are not included in our analysis (Model 1); and that when solely maternal factors are included in the analysis, these are indicated not to be statistically significant; the combination of both sociodemographic and maternal factors in the regression demonstrated how these variables as driving factors of the DBM are interlinked. Therefore resonating with this study's hypothesis that the DBM in Haiti is strongly associated with sociodemographic and maternal factors. Additionally, having identified multiple statistically significant driving factors of the DBM, as well as other household malnutrition the results of the multinomial logistic regression are likely to have important implications for policy development, as well as further research on this topic in Haiti.

7. Discussion:

7.1. Prevalence of Household Malnutrition in Haiti:

This study demonstrated that the prevalence of the DBM in Haiti is of 4.6%, while the prevalence of households with overweight or obese mothers with non-stunted children was of 30.4% and households with only stunted children was of 16.1%. While the current prevalence of the DBM in Haiti is lower than the other studied types of households malnutrition, it is important to note that based on currently available literature, Haiti nearly reaches the general level of DBM found in LMICs households (Garrett and Ruel 2003, 2005; Shrimptona and Rokx 2012). Moreover, when taking into account regional variations, Haiti's level of DBM at the household level is particularly significant, as a previous study on the global nutritional paradox demonstrated that the prevalence of this phenomenon amongst Latin American households was usually around 7% (Garrett and Ruel 2003, 2005). Therefore, this study's findings have demonstrated how Haiti is no longer an exception to the nutritional paradox, as cases of under and overnutrition within the same household are increasingly found. While issues linked to

[11] See table 6, Appendix E

undernourishment remain a public health concern, increases in the prevalence overweight and obesity as well as the DBM within Haitian households, are new public health challenges that will need to be addressed.

7.2. Driving Factors of the DBM in Haiti:

Aligned with current literature on the DBM, as well as the worldwide rise in obesity, our findings on household malnutrition in Haiti demonstrated a strong association between two of the types of household malnutrition studied and the type of place of residence. Indeed, this analysis revealed that both households with the DBM and households with overweight or obese mothers with non-stunted children were more commonly found in urban settings. These findings resonate with some of the prominent literature on the DBM and may be explained by the various diet and lifestyle changes urban environments imposes on households, such as changes in the workforces and leisure activities, increase access to process and cheaply available food, and shifts towards energy-dense diets (Popkin and Bisgrove 1988; Popkin 1998; Kennedy et al. 2006). Furthermore, while urban living was deemed not statistically significant when analysing households with only stunted children, it is important to iterate how previous literature has demonstrated that urban living can both positively and negatively affect childhood growth (Shrimptona and Rokx 2012).

Indicated to decrease the likelihood of childhood undernourishment, urbanisation, in some instances, positively affect childhood health, as urban children were said to be less likely to indirectly and directly consume pesticides, as well as to inhale indoor house smoke (Shrimptona and Rokx 2012). However, as our analysis demonstrated that the DBM was more prevalent in urban settings, it is worthwhile noting that urbanisation, particularly in LMICs that experience rapid growth, may also negatively affect childhood growth. Indeed, as rapid/unplanned urbanisation outpaces governments' ability to build essential infrastructure and services for its population, poor nutritional outcomes in urban households may arise due unregulated environmental hazards, such as urban crowding, rise in the number of slums and the creation of food deserts (Popkin 1998; Gillespie and Haddad 2001; Shrimptona and Rokx 2012). Additionally, while historically urbanisation was linked to better access to a wider variety of food and shifts towards energy dense diets (Popkin 2015), it is important to note that energy-dense foods does not necessarily mean nutrient dense diets. Therefore, urban households with energy-dense diets may lead to mothers consuming enough energy to gain weight, but impair infants' growth in as their diets are likely to be poor in micronutrients and provide suboptimal nutrition (Dieffenbach and Stein 2012).

This analysis also demonstrated that while household wealth individually affects both childhood stunting in households with normal weight mothers and excess adiposity in mothers with non-stunted children, this predictor does not significantly affect the DBM in Haiti. Moreover, unlike in previous studies which demonstrated that the DBM was usually concentrated within households with higher levels of wealth (Raj Angdembe et al. 2019; Subramanian et al. 2009) and a recent study indicating that poor Haitian urban households were more likely to be affected by the DBM (Raphaël et al. 2006), this analysis, demonstrated that, at this time, the DBM in Haiti does not significantly affect one particular wealth strata more than another. Therefore, this enables us to see that negative influences leading to Haitian households having both children with constrained growth and overweight or obese mothers are potentially caused by a multitude of non-wealth-related factors. As demonstrated in other studies, these factors may include the built environment in urban settings, as mentioned above or other individual-level factors such as adult feeding patterns, intra-household resource allocation and caring practices (Garrett and Ruel 2003; Shrimptona and Rokx 2012). However, while this study's finding on the DBM in Haiti differs from previous literature, the wealth related findings for the other studied outcomes of household malnutrition corroborates with studies demonstrating that wealth inequalities affect household nutrition, as high levels of wealth are associated with overweight or obese mothers (Subramanian and Smith 2006; Subramanian et al. 2011; Corsi et al. 2011); and lower levels of wealth continues to be a commonplace of childhood stunting (Sarma et al. 2017). Moreover, these findings enables us to see that Haiti remains at an early stage of the nutrition transition, since while the proportion of households with overweight and obese mothers increases, it remains concentrated within a higher wealth groups, particularly those with highly educated mothers that were either married or living with their partner, whereas economically disadvantaged households are still prone to childhood stunting.

Although poor childhood nutrition in LMICs is often argued to be associated with younger maternal age, due behavioural immaturity and the inability to guarantee access to an adequate dietary intake and safe WASH conditions for their children (Quarshie 2014; Fall et al. 2015; Wemakor et al. 2018); in the case of Haiti young maternal age does not significantly affect childhood stunting, nor the DBM in the studied households. Moreover, the results of this analysis demonstrated the opposite, as Haitian households with mothers of advanced maternal age, 35 and above, were more likely to show signs of a DBM, when compared to mothers between the age of 15 and 24. Furthermore, our analysis demonstrated that mothers of

advanced age were more likely of being overweight or obese in comparison to their younger counterparts. When comparing the results of this study with some of the available literature on household nutrition, our findings are congruent with studies demonstrating that overweight and obesity are nutritional outcomes commonly found in aging women (Jehn and Brewis 2009; Fall et al. 2015; Shan et al. 2018), as well as studies on the adverse effects of advanced maternal age on maternal and childhood health outcomes during and after mother's pregnancies (Sengupta et al. 2010). With regards to the DBM, advanced maternal age combined excess in adiposity may explain the pairing of stunted children with overweight or obese mothers, as a previous cohort study conducted in five LMICs – Brazil, Guatemala, India, the Philippines, and South Africa – demonstrated that advanced maternal age increased the risks of low birthweight and preterm birth, as well as stunting in infancy (Fall et al. 2015). Additionally, another study demonstrated that obesity during pregnancy was associated with delays, if not failures, in lactation which in turn caused childhood undernutrition (Black et al. 2013).

Lastly, this study's findings indicated that households with more than one child under the age of five increased the likelihood of having overweight or obese mothers paired with stunted children, as well as childhood stunting in households with normal weight mothers in Haitian households (Model 1,3,4). These findings resonate with Irarrázaval et al. (2018) study, which demonstrated that the larger the number of children in a Haitian household was associated with higher rates of childhood malnutrition, possibly due to progressive poverty or poor allocation of household goods amongst members.

As for the effect of infants' sex on the DBM and childhood stunting, it's worthwhile noting that this study's findings align with previous studies on childhood malnutrition conducted in Haiti, but differentiates themselves from studies conducted in LMICs. Moreover, whereas our findings on childhood stunting resonate with those of Irarrázaval et al. (2018) which indicated that male children were more likely to suffer from malnutrition, they differ from Tzioumis and Adair (2014) findings, which indicate that female infants were more commonly paired with overweight mothers. Therefore, by comparing these results with those of Irarrázaval et al. (2018) a potential explanation of this differing phenomenon in Haiti could be cultural practices within the household, as they demonstrated within their studies that male infants were more likely to be consuming milk formula and be introduced to solid food at an early stage in their development, in comparison to their female counterparts.

7.3. Limitations:

While the present study was able to identify factors that affect the DBM in Haiti, this research was confronted with various limitations such as data availability, as well as ethnic variations in the BMI cut-off points.

One of the limitations was that this study was dependent of secondary data sources, which contained missing, if not incomplete information. Indeed, while household data collection in Haiti has steadily improved, some limitations with the dataset, including incomplete cases and the limited coverage of groups within the Haitian population (street children and nomads) may have affected the quality of the results. Furthermore, while this study excluded cases with missing data, the unavailability of 1609 BMI measures for mothers may have affected our sample and the significance of some of the selected predictors on the outcome variables. Moreover, as it is often the poorest household that has the largest proportion of missing variables, the unavailability of these measure may have negated the effect of household wealth on the DBM in Haiti. Furthermore, albeit pregnant and post-partum mothers being excluded from the data collection on their BMI, the number of missing cases potentially reflects gaps in the data collection and/or entry in the 2016-17 Haiti DHS. Additionally, the large amount of missing household information, particularly regarding household nutrition practices and activity patterns rendered this study unable to include other potential predictors of the DBM, such as physical activity, maternal and childhood diets and childhood caregiving practices.

An additional limitation relates to the selected BMI cut-off points. Albeit the selected BMI measures enable this study to compare its findings on household malnutrition in Haiti with other LMICs, variations in BMI measures due to ethnic and biological difference in fat intake may lead to under-or overestimation of overweight and obese individuals. Moreover, whereas according to the WHO, a person with a BMI equal to or more than 25 kg/m2 is considered overweight or obese (WHO 2018b), an increasing number of studies have demonstrated that these measures are not necessarily accurate for black individuals (Rahman and Berenson 2010). Therefore BMI cut-offs specific for black individuals would have enabled us to have a more accurate evaluation of overweight and obesity in Haiti.

Lastly, another limitation of this study is that other likely pairing of household malnutrition such as overweight children/underweight mothers, overweight children/overweight mothers, stunted chid/underweight mother, were not included in this analysis as they were deemed beyond its scope. In turn, this decision may have led to this study underestimating the prevalence of household malnutrition amongst the Haitian population.

All in all, despite the above-mentioned limitations, this research was nonetheless able to uncover a number of implications for policy and future research.

7.4. Policy Implications:

Based on our analysis of household malnutrition in Haiti, as well as available data on the country's nutrition profile, it is possible to estimate that Haiti's current nutritional status falls under the second typology group developed by the FAO (Kennedy et al. 2006). As different typologies suggest different areas of focus when addressing malnutrition within a country, this study's findings on household malnutrition in Haiti demonstrate that future effective nutritional interventions and policies will potentially need to address under-and overnutrition within the Haitian population simultaneously. Additionally, based on recommendation given to other countries in the same typology group, additional focus on early detection and treatment, in addition to prevention will also become increasingly necessary (Gillespie and Haddad 2001; Kennedy et al. 2006). Therefore, as recent reports indicated that Haiti is currently working on a new National Food and Nutrition Sovereignty and Security Policy with various international partners (USAID 2018), when drafting this document along with other nutrition programmes it will be critical to incorporate these findings on household malnutrition, to ensure that both existing and new policies target the most susceptible, all the while accounting for regional variations. As this study's findings demonstrated that the causes of household malnutrition are multifaceted, Gillespie and Haddad (2001) recommendation of combining various types of interventions, including infant feeding, on-site or take-home feeding programmes, better urban households access to food, improved family planning services for mothers, particularly those of advanced maternal age, could potentially be an effective measure to directly affect malnutrition. Moreover, while these measures individually could effectively address part of the issues, Gillespie and Haddad (2001) demonstrated that the synergy of such interventions could have a multiplicative effect.

While current nutritional strategies in Haiti focus on a preventive approach addressing all types of malnutrition throughout an individual's life course by promoting infant feeding, vaccination and agriculture (FAO et al. 2012) this study's findings indicate that it would be important to place additional considerations on options addressing urban nutritional problems. These policy and programme options may include addressing issues often associated with urban living in LMICs such as poor environmental conditions, high food price, inadequate food-market structure and the lack of nutrition-related information (Popkin and Bisgrove 1988).

7.5. Contribution and Further Research:

Although literature on the double burden of malnutrition has increasingly become available over the last few decades, this study is one of few studying household malnutrition, specifically the DBM, in Haiti (Raphaël et al. 2006; Rollet et al. 2014; Irarrázaval et al. 2018). However, albeit this study utilising a vast array of factors in order to identify driving factors of household malnutrition in Haiti, future research should seek to identify additional population and individual level factors of household malnutrition, particularly the DBM, to better inform programming, as well as future literature. Additionally, as malnutrition is a complex phenomenon affected by a range of factors, follow-up studies could potentially include more in-depth, as well as expanded considerations of sociodemographic, as well as individual level determinants of malnutrition (Rollet et al. 2014). Future research would also benefit from utilising qualitative or longitudinal research methods to identify behavioural determinants, as well as evaluate individual level contributors of household malnutrition, including dietary intake, physical activity, caregiving practises, community and cultural determinants. Furthermore, as household malnutrition seem to affect mothers of advanced age more than young mothers in Haiti, regardless of the country's early childbearing age (USAID 2018), this study's findings have demonstrated the potential need for more country-specific evidence on the effects of advanced maternal age on childhood growth.

Lastly, albeit the increasing availability of data on household nutrition, it will also be beneficial for future research to be involved in the development and/or improvement of biomarkers, as well as other country-specific, if not generalisable, measures of household nutrition (Black et al. 2013). This along with more robust data collection could enable the Haitian state to guide and better inform their intervention, all the while increasing knowledge on nutritional conditions in Haiti.

8. Conclusion

While Haiti has continuously been described as an exception to the DBM in Latin America, as well as globally, this study demonstrated that this country is no longer exempt, as the DBM amongst Haitian household nearly reaches similar levels as its Latin American neighbours. Additionally, as Haiti transitions towards new stages within the demographic and epidemiological transitions, this study demonstrated that albeit issues associated with undernourishment remaining a public health concern, the rising prevalence of overweight and obese mothers, along with the DBM, consequently led to the rise of new public health issues.

Therefore, challenging assumptions relating to undernutrition and overnutrition being opposite health issues affecting specific populations more than others, this study's findings illustrates the need to simultaneously address the nutritional paradox within both the Haitian population and Haitian households. Falling under the FAO's typology two groupings regarding malnutrition (Kennedy et al. 2006), this study recommends that future nutritional programmes and policies in Haiti focus on preventive measures, along with detection and treatment considerations.

Seeking to identify driving factors of the DBM at the household level in Haiti, this study also demonstrated that four of the selected predictors significantly affected the DBM in Haiti, when models included both sociodemographic and maternal factors, as well as sociodemographic, maternal and childhood factors. Resonating with previous studies on household malnutrition, the statistically significant predictors of the DBM were urbanisation, the number of infants in the household, maternal age, specifically advanced maternal age, and the sex of the child. In such, this study's conclusion is that, based on the available data within the 2016-17 Haiti DHS, the DBM is significantly associated with sociodemographic, maternal and childhood factors of household malnutrition. As the underlying causes of the DBM have been argued to be multifaceted, this study's findings also corroborate this statement by demonstrating that sociodemographic and individual-level factors of household malnutrition in Haiti are interlinked. Given the interconnectedness of some of the selected predictors, this study's findings also illustrate the need to potentially combined nutritional interventions based on the various types of household malnutrition, all the while targeting specific population based on the type of place of residence, the number of infants in the household, as well as their age and sex, in order to address issues relating to household malnutrition. Additionally, while wealth was demonstrated to not significantly affect the DBM, this study's findings on this predictor's effects on other types of household malnutrition nonetheless important. Indeed, this study revealed that Haiti remains at an early stage of Popkin's (2002) nutrition transition, as overnutrition remains concentrated within higher wealth groups and childhood stunting significantly affect households with lower levels of wealth.

In the end, while this study was able to identify driving factors of various types of household malnutrition in Haiti, future research should consider exploring additional driving factors of the DBM to further inform programming. Rigorous data collection on behavioural factors, as well as household measures linked to malnutrition, such as WASH conditions, are further research avenues to be explored.

9. Bibliography:

Abbi, Rita, Parul Christian, Sunder Gujral, and Tara Gopaldas. 1991. "The Impact of Maternal Work Status on the Nutrition and Health Status of Children." *Food and Nutrition Bulletin*. Vol. 13. https://journals.sagepub.com/doi/pdf/10.1177/156482659101300128.

Abdullah, Asnawi. 2015. "The Double Burden of Undernutrition and Overnutrition in Developing Countries: An Update." *Current Obesity Reports* 4 (3): 337–49. https://doi.org/10.1007/s13679-015-0170-y.

Angdembe, Mirak Raj, Bishnu Prasad Dulal, Kreepa Bhattarai, and Sumit Karn. 2019. "Increased Risk of Low Birthweight and Preterm Birth, Stunting in Infancy, Short Adult Height, Poor Schooling, and Higher Adult Fasting Glucose Concentrations. The." *International Journal for Equity in Health* 18 (42). https://doi.org/10.1186/s12939-019-0944-z.

Bates, Katie, Arjan Gjonça, and Tiziana Leone. 2017. "Double Burden or Double Counting of Child Malnutrition? The Methodological and Theoretical Implications of Stuntingoverweight in Low and Middle Income Countries." *Journal of Epidemiology and Community Health* 71 (8): 779–85. https://doi.org/10.1136/jech-2017-209008.

Black, Robert E., Cesar G. Victora, Susan P. Walker, Zulfiqar A. Bhutta, Parul Christian, Mercedes De Onis, Majid Ezzati, et al. 2013. "Maternal and Child Undernutrition and Overweight in Low-Income and Middle-Income Countries." *The Lancet* 382 (9890): 427–51. https://doi.org/10.1016/S0140-6736(13)60937-X.

Bogentson, André. 2011. "La Transition Démographique En Haiti (Demographic Transition in Haïti)." *Bulletin de l'Association de Géographes Français* 88 (1): 83–104. https://doi.org/https://doi.org/10.3406/bagf.2011.8207.

Cai, Wei. 2014. "Nutritional Challenges for Children in Societies in Transition." *Current Opinion in Clinical Nutrition and Metabolic Care* 17 (3): 278–84. https://doi.org/10.1097/MCO.0000000000000042.

CIA. 2019. "Central America : Haiti." The World Factbook. 2019. https://www.cia.gov/library/publications/the-world-factbook/geos/ha.html.

Corsi, Daniel J., Jocelyn E. Finlay, and S. V. Subramanian. 2011. "Global Burden of Double Malnutrition: Has Anyone Seen It?" *PLoS ONE* 6 (9): 1–13. https://doi.org/10.1371/journal.pone.0025120.

Croft, Trevor N, Aileen M J Marshall, and Courtney K Allen. 2018. "Guide to DHS

Statistics." Rockville, Maryland, USA. www.DHSprogram.com.

Dang, Archana, and J V Meenakshi. 2017. "The Nutrition Transition and the Intra-Household Double Burden of Malnutrition in India." 725. Tokyo. https://www.adb.org/publications/nutrition-transition-household-.

Dieffenbach, Sara, and Aryeh D Stein. 2012. "Stunted Child/Overweight Mother Pairs Represent a Statistical Artifact, Not a Distinct Entity." *The Journal of Nutrition Community and International Nutrition* 142 (Vol.142(4)): 771–73. https://doi.org/10.3945/jn.111.153387.

Doak, Colleen M, Linda S Adair, Carlos Monteiro, and Barry M Popkin. 2000. "Overweight and Underweight Coexist within Households in Brazil, China and Russia 1." *J. Nutr.* Vol. 130. https://academic.oup.com/jn/article-abstract/130/12/2965/4686242.

Drewnowski, Adam, and Barry M. Popkin. 1997. "The Nutrition Transition: New Trends in the Global Diet." *Nutrition Reviews* 55 (2): 31–43. https://watermark.silverchair.com/nutritionreviews55-0031.pdf?token=AQECAHi208BE49Ooan9kkhW_Ercy7Dm3ZL_9Cf3qfKAc485ysgAAAo4wggKKBgkqhkiG9w0BBwagggJ7MIICdwIBADCCAnAGCSqGSIb3DQEHATAeBglghkgBZQMEAS4wEQQMm3BE6f2Mma3YEnguAgEQgIICQdKo3exPCpD9ecYf4VmOpjA1GS6ng_5.

Fall, Caroline H D, Harshpal Singh Sachdev, Clive Osmond, Maria Clara Restrepo-Mendez, Cesar Victora, Reynaldo Martorell, Aryeh D Stein, et al. 2015. "Association between Maternal Age at Childbirth and Child and Adult Outcomes in the Offspring: A Prospective Study in Five Low-Income and Middle-Income Countries (COHORTS Collaboration)." *The Lancet Global Health* 3 (7): e366–77. https://doi.org/10.1016/S2214-109X(15)00038-8.

FAO, IFAD, OMS, Unicef, WFP. 2012. "Haïti : Nutrition En Lettres et En Chiffres." Haiti. https://mspp.gouv.ht/site/downloads/Brochure Nutrition 2017.pdf.

FAO, IFAD, UNICEF, WFP, and WHO. 2017. "The State of Food Security and Nutrition in the World 2017." Rome. www.fao.org/publications.

Garrett, James L., and Marie T. Ruel. 2005. "Stunted Child–Overweight Mother Pairs: Prevalence and Association with Economic Development and Urbanization." *Food and Nutrition Bulletin* 26 (2): 209–21. www.measuredhs.com.

Garrett, James L, and Marie T Ruel. 2003. "Stunted Child-Overweight Mother Pairs: An Emerging Concern?" Washington. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.58.3600&rep=rep1&type=pdf

.

Gillespie, Stuart;, and Lawrence Haddad. 2001. “Attacking the Double Burden of Malnutrition in East Asia and the Pacific.” *The Asian Development Bank Nutrition and Development Series*. https://doi.org/doi:10.1596/26102.

Hawkes, Corinna. 2006. “Uneven Dietary Development: Linking the Policies and Processes of Globalization with the Nutrition Transition, Obesity and Diet-Related Chronic Diseases.” *Globalization and Health* 2: 1–18. https://doi.org/10.1186/1744-8603-2-4.

Hong, Rathavuth, James E Banta, and Jose A Betancourt. 2006. “Relationship between Household Wealth Inequality and Chronic Childhood Under-Nutrition in Bangladesh.” *International Journal for Equity in Health* 5 (15): 1–10. https://doi.org/10.1186/1475-9276-5-15.

Horiuchi, Shiro. 1999. “Epidemiological Transitions in Developed Countries: Past, Present and Future.” In , 54–71.

Huynh, Giao, Quynh H Ngoc Huynh, Ngoc Han, T Nguyen, Quang Thanh Do, and Van Khanh Tran. 2019. “Malnutrition among 6–59-Month-Old Children at District 2 Hospital, Ho Chi Minh City, Vietnam: Prevalence and Associated Factors.” *BioMed Research International*. https://doi.org/10.1155/2019/6921312.

ICF. 2017. “Dataset Types.” The DHS Program. 2017. https://dhsprogram.com/data/Dataset-Types.cfm.

———. 2019a. “Protecting the Privacy of DHS Survey Respondents.” The DHS Program. 2019. https://dhsprogram.com/What-We-Do/Protecting-the-Privacy-of-DHS-Survey-Respondents.cfm.

———. 2019b. “Wealth Index.” The DHS Program. 2019. https://dhsprogram.com/topics/wealth-index/Index.cfm.

ICF, Institut Haïtien de l’Enfance (IHE). 2018. “Haïti Enquête Mortalité, Morbidité et Utilisation Des Services (EMMUS-VI 2016-2017).Pdf.” Pétion-Ville, Haïti; Rockville, Maryland, USA.

IHME. 2019. “GBD Compare | IHME Viz Hub - Haiti.” 2019. https://vizhub.healthdata.org/gbd-compare/.

Irarrázaval, Belén, Salesa Barja, Edson Bustos, Romel Doirsaint, Gloria Senethmm, María Guzmán, Ricardo Uauy, et al. 2018. “Influence of Feeding Practices on Malnutrition in Haitian Infants and Young Children.” *Nutrients* 10 (3): 382. https://doi.org/10.3390/nu10030382.

James, W. Philip T., Rachel Leach, and Neville Rigby. 2004. “Under- and Overnutrition: A

Global Perspective." *Nestle Nutrition Workshop Series. Clinical & Performance Programme* 9: 1–17. http://www.scopus.com/inward/record.url?eid=2-s2.0-16644386220&partnerID=40&md5=52ccc8334f4b232666265bc4a3e3771c.

Jehn, Megan, and Alexandra Brewis. 2009. "Paradoxical Malnutrition in Mother-Child Pairs: Untangling the Phenomenon of over- and under-Nutrition in Underdeveloped Economies." *Economics and Human Biology* 7 (1): 28–35. https://doi.org/10.1016/j.ehb.2009.01.007.

Kennedy, G., G. Nantel, and P. Shetty. 2006. "The Double Burden of Malnutrition. Case Studies from Six Developing Countries." *FAO Food and Nutrition Paper* 84: 1–334. https://doi.org/10.1017/S0029665110003903.Contemporary.

Kuate Defo, Barthélémy. 2014. "Demographic, Epidemiological, and Health Transitions: Are They Relevant to Population Health Patterns in Africa?" *Glob Health Action* 7 (22443). https://doi.org/10.3402/gha.v7.22443.

Kulkarni, Bharati. 2018. "Addressing the Double Burden of Malnutrition in Developing Countries: Need for Strategies to Improve the Lean Body Mass." *Food and Nutrition Bulletin* 39 (2s): s69–76. https://doi.org/10.1177/0379572118768572.

Kulkarni, Bharati, Andrew P Hills, and Nuala M Byrne. 2014. "Nutritional Influences over the Life Course on Lean Body Mass of Individuals in Developing Countries." https://doi.org/10.1111/nure.12097.

Kulkarni, Vani S, Veena S Kulkarni, and Raghav Gaiha. 2017. "The Paradox of Poverty: Undernutrition and Underweight '"Double Burden of Malnutrition"': Reexamining the Coexistence of Undernutrition and Overweight Among Women in India." *International Journal of Health Services* 47 (1): 108–33. https://doi.org/10.1177/0020731416664666.

Lim, S. S., K. Allen, L. Dandona, M. H. Forouzanfar, N. Fullman, E. M. Goldberg, S. I. Hay, et al. 2016. "Measuring the Health-Related Sustainable Development Goals in 188 Countries: A Baseline Analysis from the Global Burden of Disease Study 2015." *The Lancet* 388 (10053): 1813–50. https://doi.org/10.1016/S0140-6736(16)31467-2.

Luhar, Shammi, Poppy Alice Carson Mallinson, Lynda Clarke, and Sanjay Kinra. 2018. "Trends in the Socioeconomic Patterning of Overweight/Obesity in India: A Repeated Cross-Sectional Study Using Nationally Representative Data." *BMJ Open* 8 (10): e023935. https://doi.org/10.1136/bmjopen-2018-023935.

Mamun, Sumaiya, and Christopher Guy Nicholas Mascie-Taylor. 2019. "Double Burden of Malnutrition (DBM) and Anaemia under the Same Roof: A Bangladesh Perspective." *Medical Sciences* 7(2) (20). https://doi.org/10.3390/medsci7020020.

Mistry, Sabuj Kanti, Md. Belal Hossain, Fouzia Khanam, Fahmida Akter, Mahmood Parvez, Fakir Md Yunus, Kaosar Afsana, and Mahfuzar Rahman. 2019. "Individual, Maternal- and Household-Level Factors Associated with Stunting among Children Aged 0–23 Months in Bangladesh." *Public Health Nutrition* 22 (1): 85–94. https://doi.org/10.1017/S1368980018002926.

Monteiro, Carlos A, Erly C Moura, Wolney L Conde, and Barry M Popkin. 2004. "Socioeconomic Status and Obesity in Adult Populations of Developing Countries: A Review Public Health Reviews." *Bulletin of the World Health Organization*. Vol. 82. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2623095/pdf/15654409.pdf.

Oddo, Vanessa M, Jee H Rah, Richard D Semba, Kai Sun, Nasima Akhter, Mayang Sari, Saskia De Pee, Regina Moench-Pfanner, Martin Bloem, and Klaus Kraemer. 2012. "Predictors of Maternal and Child Double Burden of Malnutrition in Rural Indonesia and Bangladesh 1-3." *The American Journal of Clinical Nutrition* 95 (4): 951–58. https://doi.org/10.3945/ajcn.111.026070.

Omran, Abdel R. 1971. "The Epidemiologic Transition : A Theory of the Epidemiology of Population Change." *The Milbank Memorial Fund Quarterly* 49 (4): 509–38.

———. 2001. "The Epidemilogic Transition: A Theory of the Epidemiology of Population Change." *Bulletin of the World Health Organization* 79 (2): 161.

———. 2005. "The Epidemiologic Transition: A Theory of the Epidemiology of Population Change." *Milbank Quarterly* 83 (4): 731–57. https://doi.org/10.1111/j.1468-0009.2005.00398.x.

Popkin, Barry M. 1993. "Nutritional Patterns." *Population and Development Review* 19 (1): 138–57. https://www.jstor.org/stable/pdf/2938388.pdf?refreqid=excelsior%3A45edbc6ed3860f83340514091352dd7c.

———. 1998. "Worldwide Trends in Obesity." *The Journal of Nutritional Biochemistry* 9 (9): 487–88. https://doi.org/10.1016/S0955-2863(98)00011-4.

———. 2001. "The Nutrition Transition and Obesity in the Developing World." In *JN The Journal of Nutrition*, 871–73. https://doi.org/10.1006/bbrc.1995.1827.

———. 2002. "An Overview on the Nutrition Transition and Its Health Implications: The Bellagio Meeting." *Public Health Nutrition* 5 (1a): 93–103. https://doi.org/10.1079/PHN2001280.

———. 2009. "The Nutrition Transition in Low-Income Countries: An Emerging Crisis." *Nutrition Reviews* 52 (9): 285–98. https://doi.org/10.1111/j.1753-4887.1994.tb01460.x.

———. 2015. “Nutrition Transition and the Global Diabetes Epidemic.” *Curr Diab Rep* 15(9) (64). https://doi.org/10.1007/s11892-015-0631-4.

Popkin, Barry M., and Florentino S. Solon. 1976. “Income, Time, the Working Mother and Child Nutriture.” *Environmental Child Health* 22 (4): 156–66. https://academic.oup.com/tropej/article-abstract/22/4/156/1704513.

Popkin, Barry M, and Eilene Z Bisgrove. 1988. “Nutrition and Urbanization (Part 2) Urbanization and Nutrition in Low-Income Countries.” *Food and Nutrition Bulletin*. Vol. 10. https://journals.sagepub.com/doi/pdf/10.1177/156482658801000118.

Powell, Alvin. 2011. “Twin Dangers: Malnutrition and Obesity – Harvard Gazette.” The Harvard Gazette. 2011. https://news.harvard.edu/gazette/story/2011/04/twin-dangers-malnutrition-and-obesity/.

Quarshie, Ethel Mannzamako. 2014. “Comparative Nutritional Status of Adult and Adolescent Mothers and Their Infants.” University of Ghana. http://ugspace.ug.edu.ghhttp//ugspace.ug.edu.gh.

Rahman, Mahbubur, and Abbey B Berenson. 2010. “Accuracy of Current Body Mass Index Obesity Classification for White, Black and Hispanic Reproductive-Age Women.” *Obstet Gynecol* 115 (5): 982–88. https://doi.org/10.1097/AOG.0b013e3181da9423.

Raphaël, Darline, Hélène Delisle, and Colette Vilgrain. 2005. “Households with Undernourished Children and Overweight Mothers: Is This a Concern for Haiti?” *Ecology of Food and Nutrition* 44 (2): 147–65. https://doi.org/10.1080/03670240590923550.

———. 2006. “Households with Undernourished Children and Overweight Mothers: Is This a Concern for Haiti?” *Ecology of Food and Nutrition* 44 (2): 147–65. https://doi.org/10.1080/03670240590923550.

Rashad, Ahmed Shoukry, and Mesbah Fathy Sharaf. 2015. “Does Economic Growth Reduce Child Malnutrition in Egypt ? New Evidence from National Demographic and Health Survey.” Alberta, Edmonton, Canada. https://doi.org/10.13140/RG.2.1.4931.7526.

———. 2019. “Does Maternal Employment Affect Child Nutrition Status? New Evidence from Egypt.” *Oxford Development Studies ISSN:* 47 (1): 48–62. https://doi.org/10.1080/13600818.2018.1497589.

République d’Haïti, Unicef, and WFP. 2012. “Rapport de l’enquête Nutritionnelle National Avec La Méthodologies SMART.” http://mspp.gouv.ht/site/downloads/SMART.pdf.

Rollet, S. R., E. S. Gray, H. Previl, and J. E. Forrester. 2014. “Prevalence of Malnutrition in Children under Five and School-Age Children in Milot Valley, Haiti.” *Public Health*

128 (12): 1094–98. https://doi.org/10.1016/j.puhe.2014.10.002.

Rutstein, Shea O., and Johnson Kiersten. 2004. "The DHS Wealth Index." Calverton, Maryland, U.S.A. http://www.measuredhs.comorbycontacting.

Rutstein, Shea O. 2008. "The DHS Wealth Index: Approaches for Rural and Urban Areas." www.measuredhs.com.

Sarma, Haribondhu, Jahidur Rahman Khan, Mohammad Asaduzzaman, Fakhar Uddin, Sayeeda Tarannum, Md Mehedi Hasan, Ahmed Shafiqur Rahman, and Tahmeed Ahmed. 2017. "Factors Influencing the Prevalence of Stunting Among Children Aged Below Five Years in Bangladesh." *Food and Nutrition Bulletin* 38 (3): 291–301. https://doi.org/10.1177/0379572117710103.

Sekiyama, Makiko, Hong Jiang, Budhi Gunawan, Linda Dewanti, Ryo Honda, Hana Shimizu-Furusawa, Oekan Abdoellah, et al. 2015. "Double Burden of Malnutrition in Rural West Java: Household-Level Analysis for Father-Child and Mother-Child Pairs and the Association with Dietary Intake." *Nutrients* 7 (10): 8376–91. https://doi.org/10.3390/nu7105399.

Sengupta, Paramita, Nina Philip, and A I Benjamin. 2010. "Epidemiological Correlates of Under-Nutrition in Under-5 Years Children in an Urban Slum of Ludhiana." *Health and Population: Perspectives and Issues*. Vol. 33. http://medind.nic.in/hab/t10/i1/habt10i1p1.pdf.

Shan, Dan, Pei-Yuan Qiu, Yu-Xia Wu, Qian Chen, Ai-Lin Li, Sivakumar Ramadoss, Ran-Ran Wang, and Ya-Yi Hu. 2018. "Pregnancy Outcomes in Women of Advanced Maternal Age: A Retrospective Cohort Study from China." *Scientific Reports* 8 (1): 12239. https://doi.org/10.1038/s41598-018-29889-3.

Shetty, Prakash S. 2016. "Nutrition Transition in India" 5: 175–82. https://doi.org/10.1079/PHN2001291.

Shrimptona, Roger, and Claudia Rokx. 2012. *The Double Burden of Malnutrition: A Review of Global Evidence. Health, Nutrition, and Population (HNP) Discussion Paper*. Vol. 13. Washington: The International Bank for Reconstruction and Development / The World Bank. https://doi.org/10.1093/humrep/13.1.27.

Subramanian, S V, Jessica M Perkins, and Kashif T Khan. 2009. "Do Burdens of Underweight and Overweight Coexist among Lower Socioeconomic Groups in India?" *Am J Clin Nutr* 90: 369–76. https://doi.org/10.3945/ajcn.2009.27487.

Subramanian, S V, Jessica M Perkins, and George Davey Smith. 2011. "Weight of Nations: A Socioeconomic Analysis of Women in Low-to Middle-Income Countries." *Am J Clin*

Nutr 93: 413–34. https://doi.org/10.3945/ajcn.110.004820.

Subramanian, S V, and George Davey Smith. 2006. "Patterns, Distribution, and Determinants of under-and Overnutrition: A Population-Based Study of Women in India 13." https://academic.oup.com/ajcn/article-abstract/84/3/633/4648904.

The World Bank. 2014. "Living Conditions in Haiti's Capital Improve, but Rural Communities Remain Very Poor." 2014. https://www.worldbank.org/en/news/feature/2014/07/11/while-living-conditions-in-port-au-prince-are-improving-haiti-countryside-remains-very-poor.

———. 2019. "The World Bank in Haiti: Overview." 2019. https://www.worldbank.org/en/country/haiti/overview.

Tzioumis, Emma, and Linda S Adair. 2014. "Childhood Dual Burden of Under-and over-Nutrition in Low-and Middle-Income Countries: A Critical Review." *Food Nutr Bull.* 35 (2): 230–43. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4313560/pdf/nihms658283.pdf.

UNICEF. 2019. "Malnutrition in Children." 2019. https://data.unicef.org/topic/nutrition/malnutrition/.

USAID. 2018. "Haiti: Nutrition Profile." https://www.usaid.gov/sites/default/files/documents/1864/Haiti-Nutrition-Profile-Mar2018-508.pdf.

Wemakor, Anthony, Humphrey Garti, Thomas Azongo, Helene Garti, and Ambrose Atosona. 2018. "Young Maternal Age Is a Risk Factor for Child Undernutrition in Tamale Metropolis, Ghana." *BMC Research Notes* 11 (877): 1–5. https://doi.org/10.1186/s13104-018-3980-7.

West, Keith P., Christine P. Stewart, Benjamin Caballero, and Robert E. Black. 2012. "Nutrition." In *Global Health: Diseases, Programs, Systems, and Policies*, edited by Michael H. Merson, Robert E Black, and Anne Mills, 3rd ed., 243–344. Burlington, MA: Jones & Bartlett Learning.

WHO. 2007a. "BMI-for-Age Boys: 5-19 Years (z-Scores)." https://www.who.int/growthref/bmifa_boys_z_5_19_labels.pdf?ua=1.

———. 2007b. "BMI-for-Age Girls: 5-19 Years (z-Scores)." https://www.who.int/growthref/bmifa_girls_z_5_19_labels.pdf?ua=1.

———. 2015. "Stunting in a Nutshell." WHO. World Health Organization. 2015. https://www.who.int/nutrition/healthygrowthproj_stunted_videos/en/.

———. 2018a. "Noncommunicable Diseases Country Profile: Haiti."

https://www.who.int/nmh/countries/hti_en.pdf?ua=1.

———. 2018b. “Obesity and Overweight.” 2018. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

———. 2019a. “Country Profile: Haiti.” WHO. World Health Organization. 2019. https://www.who.int/countries/hti/en/.

———. 2019b. “Body Mass Index - BMI.” World Health Organization. August 8, 2019. http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi.

Wise, Jacqui. 2014. “Obesity Rates Rise Substantially Worldwide.” *BMJ*, 348:g3582. https://doi.org/10.1016/S0140-6736(14)60460-8.

World Bank. 2018a. “Haiti - Fertility Rate 2016.” World Development Indicators. 2018. https://www.statista.com/statistics/576437/fertility-rate-in-haiti/.

———. 2018b. “Haiti - Life Expectancy at Birth 2016.” World Development Indicators. 2018. https://www.statista.com/statistics/576442/life-expectancy-at-birth-in-haiti/.

10. Appendix A

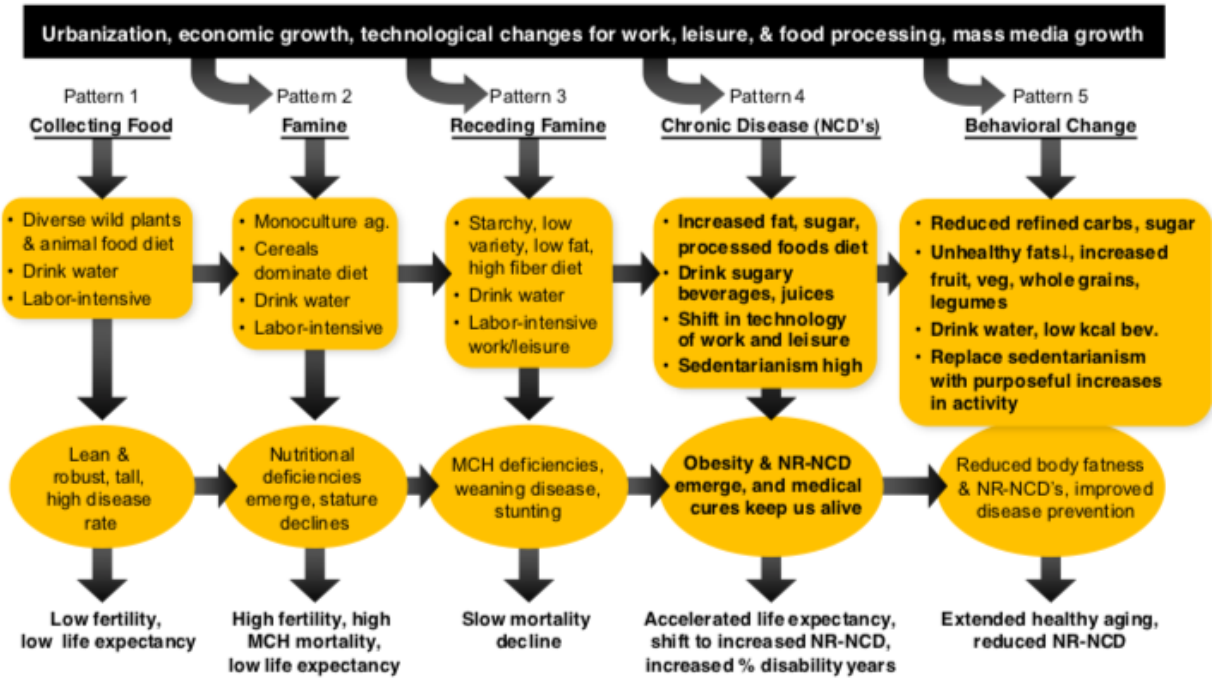

Figure 3: Stages of the Nutrition Transition
Source: Popkin, 2015

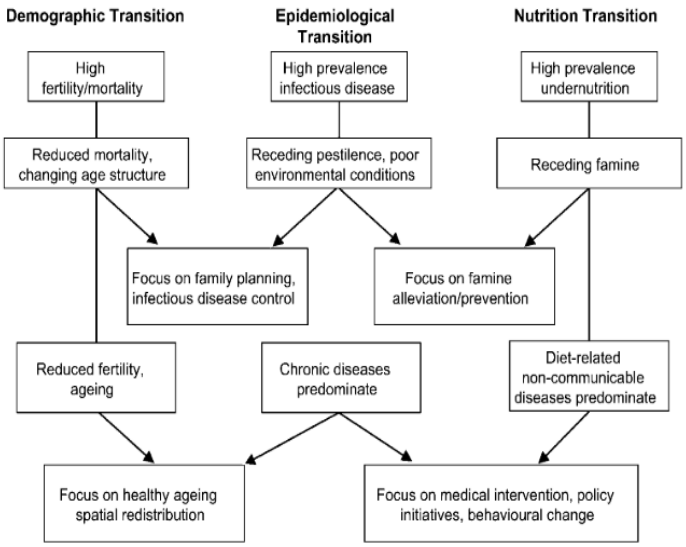

Figure 2: Stages of Health, Nutritional and Demographic Change
Source: Popkin, 2002

11. Appendix B

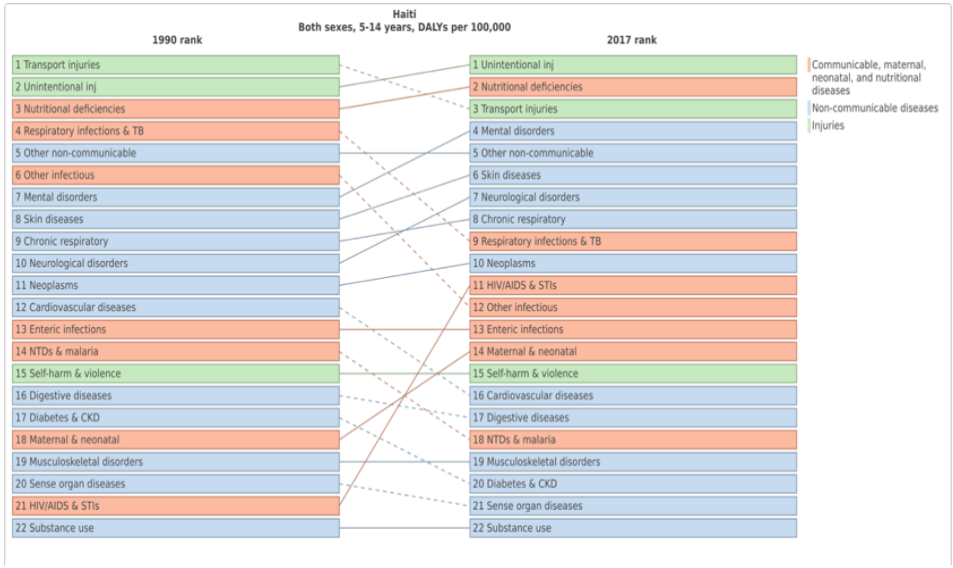

Figure 4: Ranked DALYS For Haitian Children Between The Age Of 5-14 Years Old
Source: IHME, 2019

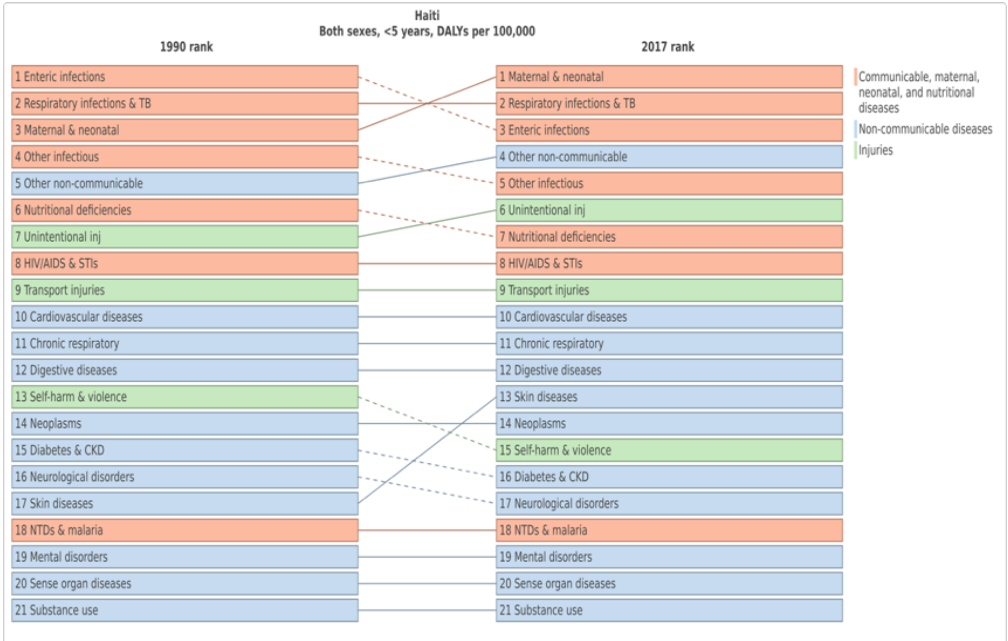

Figure 5: Ranked DALYS for Haitian Children between the Age of 5-14 years old
Source: IHME, 2019

12. Appendix C

Table 3: Descriptive statistics on Explanatory Variables

	Household malnutrition							
	Normal Weight mothers with Non-Stunted Children		Normal Weight mothers with Stunted Children		Overweight Mothers with Non-Stunted Children		DBM: Overweight Mothers with Stunted Children	
Variables	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Sociodemographic Variables								
Type of place of Residence								
Urban	554	34.5%	139	26.2%	470	47.2%	56	37.1%
Rural	1051	65.5%	391	73.8%	526	52.8%	95	62.9%
Household Wealth								
Low	746	46.5%	347	65.5%	313	31.4%	75	50.0%
Middle	315	19.6%	106	20.0%	164	16.5%	36	24.0%
High	544	33.9%	77	14.5%	519	52.1%	39	26.0%
Number of Children 0-59 months								
0	160	10.0%	6	1.1%	77	7.7%	1	0.7%
1	840	52.3%	205	38.8%	614	61.5%	55	36.4%
2	450	28.0%	226	42.7%	256	25.7%	64	42.4%
3	111	6.9%	56	10.6%	40	4.0%	20	13.2%
4	37	2.3%	20	3.8%	6	0.6%	8	5.3%
5	7	0.4%	13	2.5%	4	0.4%	3	2.0%
6	1	0.1%	2	0.4%	0	0.0%	0	0.0%
7	1	0.1%	1	0.2%	1	0.1%	0	0.0%
Maternal Variables								
Age								
15-24	540	33.6%	177	33.4%	160	16.0%	26	17.2%
25-34	706	44.0%	205	38.7%	527	52.9%	84	55.6%
35-45	359	22.4%	148	27.9%	310	31.1%	41	27.2%
Current Marital Status								
Never in Union	177	11.0%	32	6.0%	40	4.0%	3	2.0%
Married or Living with Partner	1289	80.3%	470	88.7%	890	89.3%	139	92.7%
Widowed, Divorced or Separated	139	8.7%	28	5.3%	67	6.7%	8	5.3%
Highest Educational Level								
No Education	298	18.6%	159	30.0%	116	11.6%	32	21.2%
Primary	590	36.8%	235	44.3%	350	35.1%	63	41.7%
Secondary	670	41.8%	127	24.0%	459	46.0%	52	34.4%

Higher	46	2.9%	9	1.7%	72	7.2%	4	2.6%
Occupation								
Unemployed / Unclassified	566	35.3%	198	37.4%	291	29.2%	41	27.3%
Domestic Labour / Self-Employed	187	11.7%	91	17.2%	81	8.1%	12	8.0%
Service Sector	821	51.2%	233	44.0%	603	60.5%	93	62.0%
Manual Labour	31	1.9%	7	1.3%	22	2.2%	4	2.7%
Childhood Variables								
Sex of Child								
Male	770	48.0%	295	55.7%	485	48.6%	81	54.0%
Female	835	52.0%	235	44.3%	512	51.4%	69	46.0%

13. Appendix D

Table 4: Multinomial logistic regression results – Driving factors of Childhood Stunting in Haiti

Normal Weight mothers with Stunted Children								
	M1		**M2**		**M3**		**M4**	
	B		B		B		B	
(Intercept)	-2.655***		-2.292***		-3.075***		-3.247***	
Predictors	*Estimate*	CI	*Estimates*	*CI*	*Estimates*	*CI*	*Estimates*	*CI*
Sociodemographic Variables								
Type of place of Residence *(Ref.Rural)*								
Urban	0.717**	0.571 - 0.900			0.920	0.718 - 1.179	0.902	0.703-1.157
Household Wealth *(Ref.Higher)*								
Low	3.288***	2.495 - 4.334			2.587***	1.917 - 3.490	2.612***	1.934-3.527
Middle	2.498***	1.795 - 3.477			2.230***	1.588 - 3.132	2.244***	1.597-3.154
Number of 0-59 Month Children								
	1.626***	1.460-1.810			1.599***	1.435 - 1.783	1.611***	1.44-1.796
Maternal Variables								
Age								
15-24			1.306	0.799 - 1.423	.834	0.969 - 0.719	0.947	0.702 - 1.278
25-34			1.104	0.694 - 1.167	.217	0.845 - 0.647	0.843	0.645 - 1.101
Current Marital Status *(Ref.Widowed, Divorced or Separated)*								
Never in Union			1.066	0.601 - 1.889	1.038	0.579 - 1.862	1.019	0.567 - 1.830
Married or Living with Partner			2.022**	1.324 - 3.089	1.680*	1.087 - 2.597	1.676*	1.084 - 2.593
Highest Educational Level *(Ref.Higher)*								
No Education			2.538*	1.191 - 5.412	1.249	0.559 - 2.791	1.207	0.539 - 2.701
Primary			1.979	0.939 - 4.173	1.096	0.502 - 2.395	1.062	0.486 - 2.322
Secondary			0.972	0.457 - 2.065	0.713	0.329 - 1.547	0.692	0.319 - 1.503
Occupation *(Ref.Manual Labour)*								
Unemployed / Unclassified			1.241	0.527 - 2.923	1.276	0.526 - 3.096	1.292	0.529 - 3.155
Domestic Labour / Self-Employed			1.493	0.620 - 3.599	1.591	0.640 - 3.952	1.595	0.638 - 3.988

Service Sector			0.940	0.401 - 2.204	1.062	0.440 - 2.562	1.073	0.442 - 2.606
Childhood Variables								
Sex of Child *(Ref.Female)*								
Male							1.450**	1.180 - 1.783
The reference category is: Normal Weight Mothers with Non-Stunted. *Note:* * p<0.05 **p<001 *** p<0.001. All models are based on 3282 household observations.								

Table 5: Multinomial logistic regression results – Driving Factors of Maternal Obesity in Haiti

Overweight/Obese Mothers with Non-Stunted Children								
	M1		**M2**		**M3**		**M4**	
	B		B		B		B	
(Intercept)	-0.128		0.540		0.202		0.187	
Predictors	*Estimates*	*CI*	*Estimates*	*CI*	*Estimates*	*CI*	*Estimates*	*CI*
Sociodemographic Variables								
Type of place of Residence *(Ref. Rural)*								
Urban	1.846***	1.560 - 2.184			1.927***	1.598 - 2.323	1.922***	1.594 - 2.317
Household Wealth *(Ref. Higher)*								
Low	0.408***	0.340 -0.490			0.439***	0.356 - 0.540	0.439***	0.357 -0.541
Middle	0.514***	0.409 - 0.644			0.524***	0.414 - 0.665	0.525***	0.414 - 0.666
Number of 0-59 Month Children								
	0.909	0.820 - 1.008			0.882*	0.792 - 0.983	0.882*	0.792 - 0.982
Maternal Variables								
Age								
15-24			0.333***	0.258 - 0.430	0.374***	0.289 - 0.485	0.373***	0.288 - 0.484
25-34			0.731**	0.599 - 0.893	0.767*	0.626 - 0.940	0.767*	0.625 - 0.940
Current Marital Status *(Ref. Widowed, Divorced or Separated)*								
Never in Union			0.612*	0.382 - 0.979	0.601*	0.374 - 0.968	0.600*	0.373 - 0.966
Married or Living with Partner			1.334	0.977 - 1.822	1.502*	1.093 - 2.064	1.502*	1.093 -2.064
Highest Educational Level *(Ref. Higher)*								
No Education			0.241***	0.155 - 0.375	0.589*	0.365 – 0.953	0.587*	0.363 -0.949
Primary			0.471***	0.315 – 0.705	0.907	0.590 - 1.392	0.903	0.588 -1.387
Secondary			0.572**	0.385 - 0.850	0.775	0.516 - 1.164	0.773	0.514 - 1.161
Occupation *(Ref. Manual Labour)*								
Unemployed / Unclassified			0.882	0.493 - 1.577	0.920	0.509 - 1.664	0.922	0.510 - 1.668
Domestic Labour / Self-Employed			0.724	0.387 - 1.352	0.703	0.372 - 1.329	0.706	0.373 - 1.334
Service Sector			0.990	0.558 - 1.755	1.012	0.565 - 1.814	1.014	0.566 - 1.817
Childhood Variables								
Sex of Child *(Ref. Female)*								
Male							1.041	0.881 - 1.229
The reference category is: Normal Weight Mothers with Non-Stunted.								
Note: * p<0.05 **p<001 *** p<0.001. All models are based on 3282 household observations.								

14. Appendix E

Table 6: Multinomial Logistic Regression Model Fit Summary

	Pseudo R-Square	
	Cox and Snell R Square	Nagelkerke R Square
Model 1	0.138	0.154
Model 2	0.107	0.119
Model 3	0.193	0.214
Model 4	0.196	0.218