Under-stunting the Child Nutrition Problem in the Philippines: Determining the Nutritional Status and Severity of Undernutrition among Children Aged 0-5 years old using Binary Logistic Regression, and Adjacent-Categories Logit Models

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ABSTRACT

In the Philippines, undernutrition is a multifaceted issue that can be affected by basic causes at the social level, underlying causes at the household level, and immediate causes as illustrated in the UNICEF conceptual framework for undernutrition. Undernutrition may restrict an individual's physical and intellectual capacity, which may negatively impact the economy. In this study, household characteristics, maternal factors, and individual traits were considered. The data was obtained from the 2013 National Nutrition Survey of the DOST-FNRI. This study utilized a logistic regression model to understand the factors that may affect the occurrence of stunting among children aged 0 to 5 years. Adjacent-categories logit model was also used to determine the significant factors that influence their severity. Results show that older children and male children are more likely to be undernourished. Larger households tend to have more undernourished children with higher severity, while children coming from households belonging to higher wealth quintiles are less likely to be stunted or be at-risk of being stunted. Nutrition programs should also be complemented with educational programs since higher educational attainment among mothers affects knowledge and practices on child care. Furthermore, livelihood programs should be strengthened to improve maternal employment, and, consequently, raise household income. The models on stunting did not only uncover its determinants but also the factors at various levels of severity.

Keywords: stunting, undernutrition, severity of undernutrition, adjacent-categories logit, logistic regression

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1. Introduction

Undernutrition is a multifaceted issue that manifests on various dimensions of life and is deeply rooted in different health, social, economic, and political aspects. The detrimental effects of undernutrition are magnified and irreversible, particularly among those who have suffered from it during the early phase of their lives. Malnutrition intensifies susceptibility to various diseases and infections which increase child mortality and morbidity (Blössner & de Onis, 2005).

Undernutrition hinders cognitive development and physical growth – eventually leading to poorer academic performance (HB 3967, 2016). According to Save the Children Philippines (2016), members of the workforce who survived child undernutrition and have enrolled in school had higher risk of grade level repetition and lower educational achievement. The educational aspect of undernutrition also contributes to economic losses. Fifteen percent of students who have repeated a grade level cost the country an additional 1.23 billion pesos to cover the expenses brought by grade level repetitions in the academic year 2013-2014 (Save the Children Philippines, 2016).

Other economic concerns include the decrease in productivity and capacity to contribute to the country's economy. The opportunity cost brought by undernutrition has a strong impact on the level of productivity of a nation since there is an alarming number of under-five deaths associated with it. In addition, it was estimated that the combined effect of the losses in education and productivity cost a total of 328 billion pesos in 2013 – which is approximately 2.84% of the country's Gross Domestic Product in the same year (Save the Children Philippines, 2016).

In order to address this issue, the study aims to determine the factors affecting stunting among children below five years old in the Philippines. This study also seeks to identify and characterize stunting at its different levels of severity.

This study shall facilitate better understanding of the current nutritional status of theFilipino children. It will also help agencies monitor the progress of their projects based on the targets that these institutions have set. Public health professionals can better understand the structure of relationships that exist among the chosen explanatory variables and this form of undernutrition, and use this study as a basis for future research with newly-obtained survey data. Policymakers may also use the model as a guide for the implementation of the RA 11148 or the "Kalusugan at Nutrisyon ng Mag-Nanay Act" and the Philippine Plan of Action for Nutrition (PPAN) 2017 - 2022. By reducing the incidence and prevalence of undernutrition, we are one step closer to making our country a better place to live in not just for the children of today, but also for the children of tomorrow.

2. Review of Related Literature

2.1 Demographic and Parental Factors

Age of Child

Studies in Africa (Nkurunziza et al., 2014; Agho et al., 2015), Indonesia (Ramli, 2009) and China (Pei, Ren, and Yan, 2014) have identified an increased risk of undernutrition with increasing age in months. Specifically, children belonging to the 23-59 months age group are more at risk of undernutrition compared with younger children, because of the protective effect of breast milk. As children grow up, they get to be introduced to other types of food. Thus, they need adequate complementary or substitute food to breast milk since inappropriate food supplementation may not fulfill a child's dietary needs. Although infants in developing countries may be well-nourished in early infancy, their nutrition rapidly deteriorates until two years of age (Martorell, 1986). Upon the third or fourth year, the child's current nutritional status remains constant.

Sex of Child

Studies in Zambia (Mzumara, 2014) and Indonesia (Ramli, 2009) identified higher prevalence of stunting among male children. This could be attributed to behavioral patterns in communities such as favoritism towards daughters. However, Mzumara (2014) have also shown that male children are also biologically more vulnerable to morbidity.

Parents' Education

Various studies in Indonesia report on the effect of parents' educational attainment in improving nutritional status. There is a higher probability of having stunted children for mothers who have never attended formal education (Rachmi et al., 2016; De Silva and Sumarto, 2018). Both the education levels of the father and the mother have significant negative effect on stunting, but the effect is larger for mothers with higher level of education. The impact of having mothers with higher level of educational attainment may be attributed to greater knowledge in childcare, feeding practices, environment, and household hygiene (Silva and De Sumarto, 2018; Nguyen and Sin, 2007).

Employment Status of Parents

Most literature on the effect of the parents' employment on child nutrition focuses on maternal employment. In Malaysia (Shuhaimi and Muniandy, 2012) and Ethiopia (Wondafrash et al., 2017), prevalence of stunting was higher among children with unemployed mothers. Maternal working hours had a positive relationship with child's weight but had a negative relationship with child's energy, protein, and fat intake. However, children of both employed and unemployed mothers did not achieve the recommended nutrition intake (Shuhaimi and Muniandy, 2012).

Studies suggest that unemployed mothers may “lack the economic means to purchase adequate food for the family than those mothers who are employed” (Wondafrash et al., 2017). However, contradicting results have been found in India. Children under three years of age with employed mothers have a higher risk of stunting. Heavy workload can decline a woman’s health and her capacity to produce optimum quantity of breast milk. Time constraints can also restrict a mother from doing other forms of child care such as cooking healthy and nutritious food (Abbi, 1991).

2.2 Household Factors

Household Income

In Malaysia (Shariff, 2015) and Indonesia (De Silva and Sumarto, 2018), studies have indicated household income as a predictor of child malnutrition. Higher income entails a stronger purchasing power to access nutrient-dense and adequate diets (Darmon, 2008; Shariff, 2015). Shariff (2015) also noted that the exposure, availability and accessibility to food at home could affect taste preference and intake of children. Given that the cost is less expensive for high-energy dense food, children in low-income households could be more exposed to high energy than high-nutrient dense food for meals and snacks at home.

Household Size

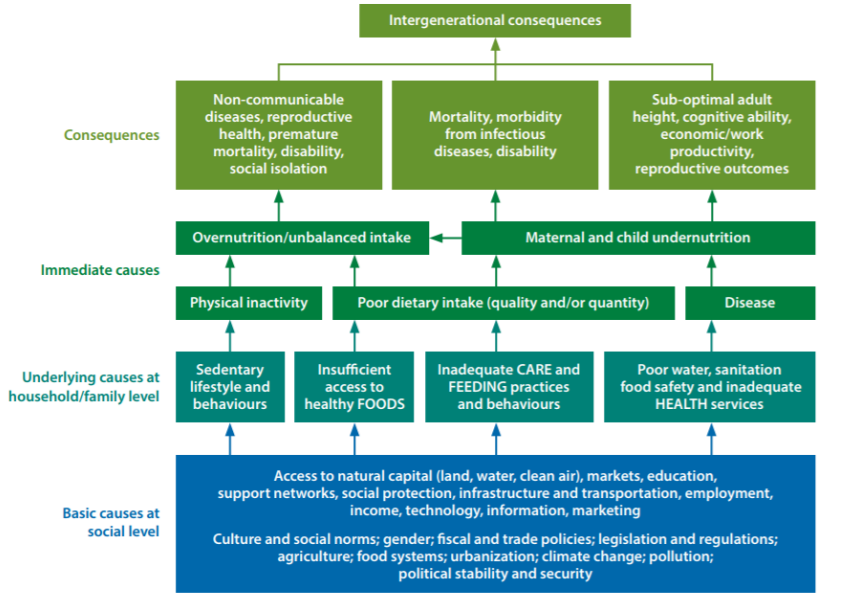
A study in Northwestern Ethiopia reported that family size is a significant predictor for stunting in school-age children. The authors suggested that it is due to lesser food availability per member and because of overcrowding, and because having a larger family size increases the risk of diseases that can lead to malnutrition (Mazengia and Biks, 2018). Furthermore, Magallanes (1984) suggested that reducing family size is more effective than increasing household income in preventing malnutrition among high-risk households.

Access to Safe Drinking Water

Cuesta (2007) reported that access to safe water sources and any kind of sanitary facility reduces the probability of birth malnutrition in Cebu, Philippines. Specifically, access to community-based piped water provision and flush toilets have the greatest probability in reducing malnutrition; especially in poor households where the odds of being undernourished are higher. A study in Bacolod and Cagayan de Oro noted that access to adequate water supply and sanitation facilities vary at different levels of income (Magnani et al., 1993), and most of the time, undernourished children live in communities where sanitation is poorer. The comparison across household types suggests that non-monetary factors are important in reducing the proportions of undernourished children. Therefore, monetary poverty reduction is unlikely to be sufficient in solving the nutrition problem of rural populations in emerging market economies (Waibel and Hohfeld, 2016).

3. Methodology
3.1. Framework of Undernutrition

Figure 1. UNICEF Conceptual Framework of Undernutrition



Note: Basic, underlying and immediate causes are included in this figure, as well as outcomes of malnutrition. Figure adapted by ASEAN, UNICEF and WHO for publication in ASEAN/UNICEF/WHO (2016) Regional Report on Nutrition Security in ASEAN, Volume 2, from the 1997 UNICEF Conceptual Framework of Malnutrition. Not to be reproduced without permission.

The study utilized the UNICEF Conceptual Framework for Malnutrition (Fig. 1) in determining the variables necessary for predicting the occurrence and severity of stunting among children aged 0 to 5 years old to ensure comparability with other studies. This is also the same framework which served as the basis for the projects in the PPAN. The variables used in the study were limited up to the underlying causes at the household level identified in the framework.

The occurrence and severity of stunting were predicted using Logistic Regression model and Adjacent-Categories Logit model, respectively. The use of the Adjacent—Categories Logit model allows us to better understand the individual categories. This analysis allows the researchers to focus on the comparison of adjacent categories which will provide them more insightful recommendations for policy-making and for other programs that aim to prevent the severity of undernutrition from worsening (Fullerton & Xu, 2015).

3.2 Dataset and Variables

The data used in the study is from the 2013 National Nutrition Survey. Data for 8,111 children aged among 0 to 5 years old are considered. The variables used in the study are indicated in the succeeding sections.

3.2.1. Response Variables

a. Nutritional Status

To determine each child's nutritional status, height-for-age z-scores (HAZ) were obtained using the Anthro ver. 3.2.2 software of the WHO since the HAZ is used to identify stunted children. A child whose anthropometric z-score falls two standard deviations below the WHO Child Growth Standards Median was marked as stunted. Observations with HAZ > 6 or < -6 were removed from the dataset since these values are considered biologically implausible by the WHO (Vollmer, Harttgen, Kupka, & Subramanian, 2017).

b. Severity of Undernutrition

In categorizing the severity of stunting into mild, moderate, and severe, the z-scores cutoffs used are -1, -2, -3, respectively (Stevens et al., 2012). These cutoff values indicate how far a child's anthropometric z-scores are from the WHO standards' median.

3.2.2 Explanatory Variables

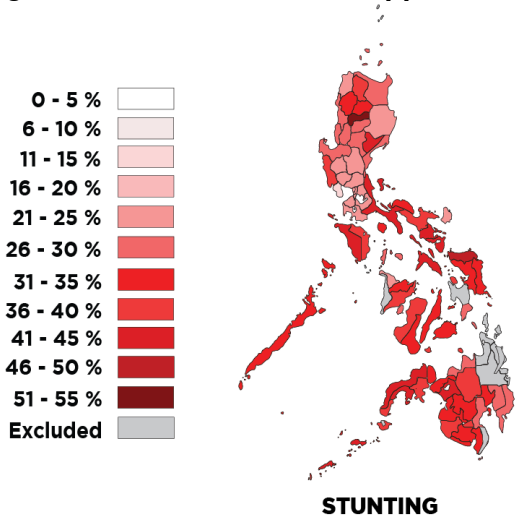
The set of explanatory variables for both logistic and adjacent categories logit models include demographic and socio-economic factors:

1. *Age of the child (in months)*
2. *Sex of the child*
3. *Household size* - The number of members in a household
4. *Wealth quintile* – The quintiles are groupings based on the income of each household. Respondents belonging to the first quintile are the poorest while those in the fifth quintile are the richest.
5. *Primary source of drinking water* – A binary variable with value equal to 0 when the water source is unimproved and with value equal to 1 if the household has improved water source. Improved sources include piped into plot or dwelling, public tap or stand pipe, tube well, borehole, protected dug well, protected spring, and rainwater. Unimproved sources include semi-protected and unprotected dug well, unprotected spring, tanker truck, cart with small tank, and surface water of rivers and dams.
6. *Mother's employment status* - A binary variable which classifies mothers as employed or unemployed. Unemployed mothers include students, housewives, and pensioners.
7. *Mother's years of schooling*

4. Results and Discussion

4.1 Descriptive Analysis

Figure 2. Thematic Map of the Prevalence of Stunting Children Aged 0 – 5 Years in the Philippines in 2013



In the Philippines, stunting is the most prevalent form of undernutrition. Provinces near the National Capital Region have relatively lower prevalence of stunting. Bicol, ARMM, and Zamboanga Peninsula are the regions with the highest prevalence of

Prior to model fitting, proportions and summary measures were obtained to characterize the severity and prevalence of stunted children aged five and below. Results of the descriptive analysis are indicated in the succeeding tables.

Table 1. Severity and Prevalence of Undernutrition among Children Ages 0-5 Years Old

Form of Undernutrition	Severity (%)			Overall Prevalence (%)
	Mild	Moderate	Severe	
Stunting	50.67	34.11	15.22	29.85

Table 1 shows that almost three out of 10 children are stunted. Severely stunted children comprise approximately 30% of the set of stunted children.

Table 2. Characteristics of Mothers in each Child Nutritional Status

	Mothers' Average Years of Schooling	Percentage of Employed Mothers
Among stunted children	11.43	25.40
Among all nourished children*	12.97	33.01

*Nourished children are those who neither stunted

Characteristics of mothers of undernourished children were also examined in Table 2. Regardless of their child's nutritional status, the average years of schooling of the mothers were approximately 12. This suggests that the mother's years of schooling may not differ between undernourished and nourished children. On the other hand, maternal employment was higher among nourished children at 33%. This is approximately 8% higher than the maternal employment among undernourished children.

Figure 3: Number of Cases of Stunted Children per Wealth Quintile

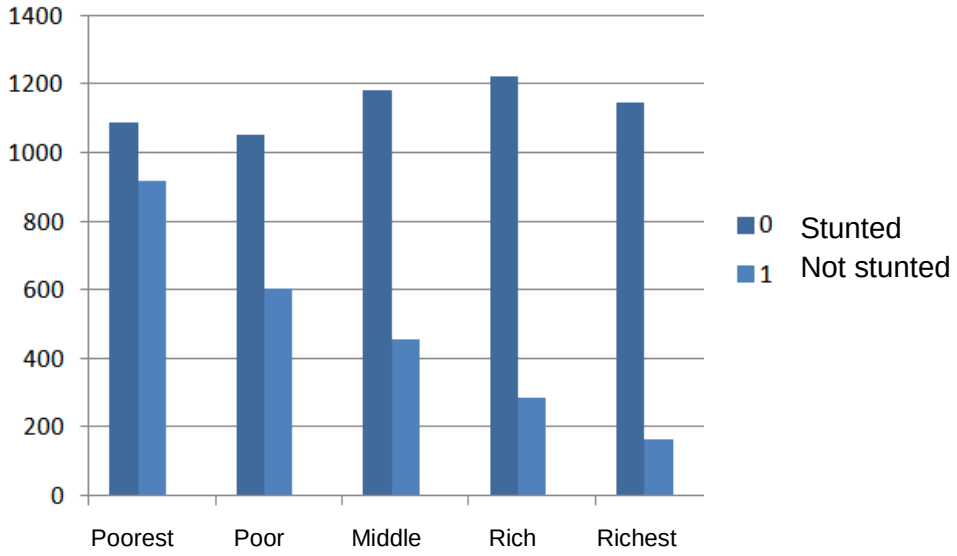


Figure 3 shows a decreasing trend in the number of cases of stunting children as the household wealth quintile increases. This suggests that child undernutrition has lower occurrence in households with higher income.

4.2 Binary Logistic Regression Models and Adjacent Categories Logit Model

Upon fitting logistic regression models for stunting, the adequacy of each model was inspected by generating diagnostics. All of the variance inflation factors (VIF) for each model indicate absence of multicollinearity. The models also have good fit based on their residual deviance. The predictive power of the logistic regression model for stunting is 64.14%. Additionally, the sensitivity is 62.65% while the specificity is 67.49%.

Table 4. Results of the Logistic Regression and Adjacent-Categories Logit Models

Parameter		LOGISTIC		ADJACENT CATEGORIES	
		Exponentiated Estimate	p-value	Exponentiated Estimate	p-value
Intercept 1		0.453	<0.000	1.133	0.266
Intercept 2		- - -	- - -	1.887	<0.000
Age in months		1.020	<0.000	0.996	0.001
Sex *(Baseline: Female)*		1.114	0.039	0.924	*0.051
Household Size		1.054	<0.000	0.974	0.001
Wealth Quintile *(Baseline: Poorest)*	Poor	0.781	<0.000	1.127	0.027
	Middle	0.554	<0.000	1.382	<0.000
	Rich	0.352	<0.000	1.787	<0.000
	Richest	0.235	<0.000	1.806	<0.000
Primary source of drinking water		- - -	- - -	- - -	- - -
Maternal Employment *(Baseline: Unemployed mother)*		0.834	0.003	- - -	- - -
Mother's Years of Schooling		0.953	<0.00	1.033	<0.000

*Significant at 0.10 level of significance

The age and sex of the child, household size and wealth quintile, and the mother's years of schooling are significant for both models. Maternal employment is only significant in determining if a child is stunted or not, while the household's primary source of drinking water is not a significant variable for stunting.

The odds of stunting increase by 26.82% for every 1-year increase in age. Similarly, the odds of having a less severe form of stunting decrease by approximately 5%. This coincides with the results of the studies of Nkurunziza (2014) and Agho (2015) which emphasize the protective effect of breast milk among younger children.

Male children tend to be stunted as compared to females, with the odds of being stunted for males being 11% higher than those of the female children. However, results have been inconsistent in different regions and countries, thus it is important to further explore the dynamics between sex and undernutrition in relatively smaller geographical areas.

Although being a significant factor, the effect of a 1-member increase in the household on the nutritional status of a child is relatively minimal with only a 5% increase in the odds of being stunted and approximately 3% decrease in the odds of having a less severe form of stunting. Based on the data, the average household size of the children, regardless of their nutritional status is approximately 7. As compared to the 4.4 national average reported by the Philippine Statistics Authority in 2015, the odds of stunting for a child belonging to a household with 7 members increases by 18%.

Consistent with literature, children who are from households from higher wealth quintiles are less likely to be stunted or at-risk of being stunted. The odds of a child from the middle quintile to be stunted are 50% lower than those from the bottom quintile. Furthermore, the odds of having less severe level of stunting for a child from the top two wealth quintiles is around 80% higher as compared to children from the poorest quintile.

On a national level, children with employed mothers are less likely to be stunted with a 17% decrease in the odds. Similar with the sex of the child, future studies that provide better understanding on the effect of having a job on a child's nutritional status is essential.

The mother's years of schooling is a vital factor in understanding the child's nutritional status. The decrease in the odds of stunting for children whose mother has only finished primary education is only 35%. If a mother finishes secondary or tertiary education, the odds of a child being stunted can decrease by 46% and 55%, respectively. Additionally, a four-year increase in the mother's years of schooling increases the odds of a child to have a less severe form of stunting to 13%. Since mothers with higher educational levels have greater knowledge in childcare, feeding practices, and household hygiene, their children are less likely to be undernourished (Silva and De Sumarto, 2018; Nguyen and Sin, 2007).

5. Conclusions and Recommendations

Stunting is the most prevalent form of undernutrition in the country and is an indicator of chronic undernutrition. The child's age and sex are significant in understanding their nutritional status, but there is no direct way to prevent children from being undernourished since these factors are uncontrollable. However, these variables can provide us a basis for nutrition programs since it can help public health officials assess which subgroups are needed to be prioritized and how the programs should be scheduled. Programs that target the first 1,000 days of life must be implemented effectively since the effects of undernutrition in this stage of life have irreversible effects on the physical and mental development of children (DOH, 2017).

Household factors such as size and wealth quintile are factors that always have to be considered in health programs, since the household size can provide an overview of how the members are sharing the resources within their household given their financial capacity, which is represented by the wealth quintile.

Given the positive impact of having mothers who are employed and have achieved higher levels of schooling on one's nutritional status, it is imperative that the government prioritizes social programs that cater to women. Educational programs will give the mothers better access to knowledge that will help them have effective childcare, feeding, and hygiene practices.

In order to achieve the target reduction in the prevalence rates of undernutirion, programs must cover all levels, starting from the individual-level up to the society in which they belong.

Nutrition programs must be complemented with livelihood, educational, and family planning programs in order, since maternal and household factors are important in preventing children from being undernourished and because of the interdependencies of these factors.

Future studies may explore other factors that are associated with the child's access to nutritious food and safe drinking water. The researchers also recommend that policymakers must look into studies that dwell on the regional or provincial determinants which can aid in large-scale program-planning in reducing undernutrition in the Philippines. Additionally, the determined factors can be used to assess ongoing government programs.

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