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| RESEARCH ARTICLE

A Silent Crisis: The Impact of Public Health Expenditure on Malnutrition Prevalence in Children Aged Below Five in the Philippines

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| ABSTRACT
This study mainly aims to determine whether public health expenditures have been effective in reducing malnutrition among children aged below five in the Philippines. The researchers construct a Grossman (1972) model-based health production function, which treats economic, social, and environmental factors as determinants of nutritional status. OLS estimates show that an increase in food security rates, a decrease in poverty incidence rates, and an increase in the level of urbanization significantly reduce stunting rates. However, no statistically significant relationship exists between the aforementioned independent variables and underweight and wasting rates (aside from the level of urbanization and wasting). In all regression models, the coefficient estimate for public health expenditure is valued near zero and is statistically insignificant, implying that government spending on health has been insubstantial and ineffective in reducing malnutrition prevalence.

| KEYWORDS
Malnutrition; stunting; underweight; wasting; Grossman model; public health expenditure; food security; poverty incidence; level of urbanization

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1. Introduction

1.1. Background of the Study

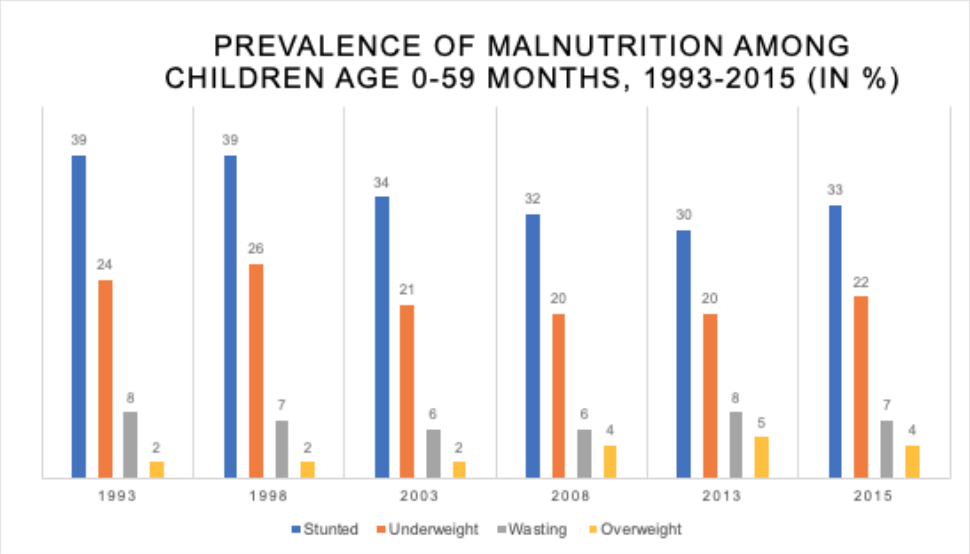
Malnutrition is a condition resulting from a poor diet that fails to provide the optimal amount of nutrients. It is an umbrella term encompassing a broad scope of conditions from undernutrition to overnutrition. Undernutrition mainly occurs when a person does not have enough to eat or has a diet that lacks proper nutrition. It is primarily divided into three sub-groups: wasting, stunting, and underweight. Wasting pertains to low weight-for-height brought about by insufficient food intake. Stunting, or low height-for-age, is caused by persistent undernutrition and has adverse and permanent effects on a child's holistic growth and development. Low weight-for-age is known as underweight; underweight children may be stunted, wasted, or both (WHO, 2020). Being afflicted with undernutrition is a significant concern since it negatively affects cognitive formation (Glewwe et al. 2001; Walker et al. 2005) and hampers the development of human capital (Glewwe and Jacoby 1995; Maluccio et al. 2006).

Despite the economic growth and unprecedented technological advancement in the past decades, malnutrition remains one of the most pressing social issues in the world. The 2018 statistics from the World Health Organization listed almost 149 million children under five as stunted and 49 million children under five as wasted. Furthermore, approximately 45% of children's mortality was attributed to undernutrition–all of which occurred in low to middle-income countries. There are a lot of underlying factors that affect malnutrition, such as economic status, population growth, food security, education, and other health factors. These different factors can further worsen the situation if not addressed immediately with such an alarming crisis.

The Philippines is not spared from malnutrition. In fact, malnutrition has been a persistent and prevalent concern in the country over the years. In order to combat malnutrition, the National Nutrition Council, under the Department of Health, was formed to

formulate, implement, and monitor nutrition programs in the Philippines. The Council formulated the Philippine Plan of Action on Nutrition (PPAN), considered the country's master plan to eradicate malnutrition. However, despite this, malnutrition remains prevalent in the country. Data from the National Nutrition Survey done by the Food and Nutrition Research Institute show that little progress has been made regarding reducing child malnutrition in the past 25 years.

Figure 1. Prevalence of Malnutrition among under-five Children in the Philippines



Source: National Nutrition Survey, Food, and Nutrition Research Institute (as mentioned in Herrin et al., 2018)

The 24% underweight rate in 1993 went down only by 2% in 2015, which implies that the country has failed to achieve the Millennium Development Goal of alleviating underweight prevalence by 2015. And with the current COVID-19 pandemic destabilizing the food security of many Filipinos, the country is positioned not to meet its Sustainable Development Goal of reducing stunting prevalence by 40% in 2025.

1.2. Statement of the Problem

Malnutrition prevalence has remained high in the country over the past year. This raises concern about whether government spending has been efficient in reducing malnutrition prevalence in the country. With this, the study seeks to answer: are public health expenditures effective in reducing malnutrition?

The primary aim of this study is to quantitatively determine the relationship between public health expenditure and malnutrition rates. More specifically, this study aims to:

1. Determine how economic, social, and environmental factors affect malnutrition prevalence;
2. Measure the change in malnutrition rates with respect to changes in public health expenditures;
3. Assess whether public health expenditures are significant in reducing malnutrition prevalence.

1.3. Formulation of Hypotheses

This study considers the following hypotheses:

Hypothesis 1:
H_o: There is no significant relationship between public health expenditure and malnutrition rates of children.
H_a: There is a significant relationship between public health expenditure and malnutrition rates of children.

Hypothesis 2:
H_o: There is no significant relationship between food security and malnutrition rates of children.
H_a: There is a significant relationship between food security and malnutrition rates of children.

Hypothesis 3:
H_o: There is no significant relationship between poverty incidence and malnutrition rates of children.
H_a: There is a significant relationship between poverty incidence and malnutrition rates of children.

Hypothesis 4:
H_o: There is no significant relationship between urbanization and malnutrition rates of children.
H_a: There is a significant relationship between urbanization and malnutrition rates of children.

The corresponding p-values for each variable's coefficient dictate whether the mentioned variables have statistically significant relationships with each other. The p-values are tested at the 0.01, 0.05, and 0.1 levels of significance.

1.4. Scope and Limitations

This study is bound by certain limitations. First, the study is limited in utilizing cross-sectional data in 2015 since all data sources are only available in the said year. There have been difficulties acquiring longitudinal data because of the incompatibility of data sources regarding the years they were conducted in[1]. Thus, an ideal approach to analysis may not be employed, and the authors are limited to a cross-sectional analysis. Moreover, the researchers are limited to using the provincial data because data sources converge at the provincial level. With this said, the level of analysis is limited at the macro level.

In addition, some provinces were excluded from the study due to a lack of data. Batanes lacked anthropometric data since the NNS was not conducted in Batanes that year, while Apayao does not have the correct data in the 2015 Population Census. Moreover, some provinces were also excluded because of inconsistencies regarding the designation of some places. For instance, some data sources consider Isabela City part of Basilan, while others consider it a separate city in Zamboanga Region with its estimate. This is also the case for Cotabato City and North Cotabato. The data for these provinces would be inconsistent among the different data sources, leading the study to produce inaccurate results; thus, these provinces were excluded.

Lastly, the data used to represent public health expenditure is the aggregated expenditure on Health, Nutrition, and Population Control of all LGUs within a province, which tallies all health-related expenditures of LGUS. While it can be argued that this is not wholly representative of expenditure on nutrition-specific interventions (since it contains expenditure on other health-related matters aside from malnutrition), the lack of available data constrains the researchers from utilizing this data.

1.5. Significance of the Study

The primary rationale for conducting this study is to promote awareness and shed light on a silent crisis for many Filipino children. The issue of malnutrition should be given proper attention in order to produce healthier and more economically-productive Filipinos that are geared towards the holistic progress of the country.

Since malnutrition could potentially affect the country's labor force, it should be in the great interest of the government and policymakers to take action against it. With this in mind, the study could be beneficial to the following government and organizations:

For the Department of Health, this study could provide insight regarding the effectiveness of public expenditures on malnutrition. This study could help the department determine whether regional budget reassessment or realignment is needed. In addition, this study can provide insight into whether the budget allocation helps reduce malnutrition as the NNC is the primary agency for eradicating malnutrition.

For the Food and Nutrition Research Institute, the results from this study could serve as a stepping stone for the organization's future studies that focus on generating effective and efficient nutrition programs.

For civil societies organizations and advocates of malnutrition, this study could help promote their cause and generate attention towards the issue.

Lastly, this study could provide additional information to other researchers who want to conduct further research in this field.

[1] The LGU Fiscal Data, the data source for public health expenditures, are reported annually. The Full Year Official Poverty Statistics are conducted every three years. The National Nutrition Survey is conducted every 5 years, but an updating survey is conducted every two-three years. The Census of Population and Housing is conducted quintannually. All of these data sources were conducted in 2015.

2 Review of Related literature

2.1. Review of Related Literature

2.1.1. Malnutrition in the Philippines

Despite malnutrition being a burdensome problem in the Philippines, there appears to be a lack of quantitative studies that empirically assess the effectiveness of government spending towards malnutrition reduction. However, several qualitative studies have examined the role of the government in addressing the malnutrition situation in the country.

The Compendium of Action on Nutrition by UNICEF (2018), in partnership with the DOH and the NNC, documents the course of actions of eleven outstanding Local Government Units (LGUs) against malnutrition. These are the LGUs of Asipulo, Davao City, Davao del Norte, Kadingilan, Limasawa, Malungon, Mandaluyong, Quezon Province, Tagaytay City, Talibon, and Villaverde. The study gathered information through field research in each city/municipality. They conducted focus group discussions (FGD) with the nutrition committee and key informant interviews (KIIs) with the local chief executives or representatives. According to the study, good leadership is crucial in malnutrition reduction. The study points out that a good leader is "already half of the engine that runs an excellent nutrition program." Monitoring and reviewing local nutrition plans were also part of the key conclusions of the study; the aforementioned LGUs intensively monitored the people's participation, assessed their weak points, and adopted proper measures to solve them. Last, they also reinvented national nutrition programs and adopted strategies that made them more effective, attractive, and accessible to their constituents.

Another similar study was done by Herrin et al. (2018) from the Philippine Institute of Development Studies (PIDS). This study includes the most recent statistics on malnutrition and a summative list of the malnutrition-targeting programs implemented by the DOH. More importantly, this study emphasized the crucial role that local government units play in eradicating malnutrition. The study suggests two courses of action: (1) improvement of governance and current health programs; and (2) implementation of programs that fill in the deficiencies of current nutrition programs.

Vargas et al. (2017), under the Food and Nutrition Research Institute (FNRI), conducted a study on malnutrition from 1989-2015. The authors noted that the trend of malnutrition in the Philippines has remained unchanged over the years; however, the number of overweight/obese became more prevalent among Filipino adults. Utilizing data from the National Nutrition Survey and employing multiple regression analysis, the authors determined factors that significantly affected Filipinos' nutrition. Factors that affect undernutrition among children include age, household wealth status, household food security status, energy intake, and drinking water is given. On the other hand, factors that affect overnutrition among adults are age, sex, work status, energy intake, household wealth status, household's food security status, presence of electricity, place of residence, and physical activity. Interestingly, some factors affected both under- and over-nutrition, such as energy intake, wealth status, and food security.

In addition to these studies, there is a budding set of studies assessing the malnutrition situation in specific locales in the Philippines.

Gamelong (2018) identified factors that affected malnutrition among children in one barangay in Silang, Cavite. The author performed interviews and document analysis and found that the leading factors that influenced malnutrition include poor access to affordable healthcare services, lack of education of mothers, and weak financial support from the government.

Pasion (2019) identified problems encountered by the Nutrition Council in Malabon City in combating malnutrition. One of the key problems was the lack of financing from the national government. The annual budget of 300,000 pesos was insufficient to have a holistic approach towards malnutrition. With that amount, the Council only conducted annual weighing programs for children and only held feeding programs when sponsored by the national government or NGOs. Another problem was the lack of skilled personnel. The author notes that nutritionists are crucial in the Council since they are the ones who formulate and spearhead nutrition programs and coordinate with barangay health workers who implement the programs on the ground. However, the author notes a scarcity of them in the area, pointing out that the council only had one in 2014 after four resigned and were never replaced. Another critical concern was poor coordination among the Council and other key departments. All acted independently and conducted their nutrition programs, which resulted in incoherent progress.

Two studies analyzed malnutrition prevalence in Marinduque. Salvacion (2017) examined key determinants of malnutrition through a multiple regression approach. He considered socioeconomic (e.g., poverty incidence, unemployment rate) and topographic, climactic, and proximity factors. He found that climate affects malnutrition since it affects agricultural production and food security. Leyso & Palatino (2020) identified municipalities with high rates of malnutrition. They found that Boac, Buenavista, Gasan, and Torrijos, coastal municipalities, had a higher prevalence and higher risk of malnutrition because these are more prone to frequent calamities such as typhoons.

2.1.2. Role of Governments and Public Health Expenditure in Malnutrition Reduction

There is a sparsity of publicly available studies that empirically assess the effects of public health expenditure on malnutrition specifically. However, numerous studies delve into the role of government expenditure on public health.

A bulk of the studies can be found in South Africa. In Nigeria, Kojo Edeme, Emecheta, & Omeje (2017); Oluwatoyin, Folasade, & Fagbeminiyi (2016); and Eboh, Abba, Fatoye (2018) primarily examined how government spending affected health outcomes. A common similarity among the studies is that they used infant mortality rate and life expectancy at birth to proxy health outcomes. Edeme, Emecheta, & Omeje used OLS to examine how government expenditure (along with per capita income) affected life expectancy at birth and infant mortality rates. They found a positive relationship between government expenditure and the dependent variables. This could be associated with the people's increased demand for health care improvements. They also saw a positive relationship between income and the dependent variables, suggesting that as income increases, the demand for--and ability to pay for--better healthcare increases. Meanwhile, Oluwatoyin, Folasade, & Fagbeminiyi (2016) used a Vector Error Correction Model to determine whether a long-run equilibrium relationship exists between life expectancy and public health expenditure. Interestingly, they found a significant but negative relationship between their variables. The authors noted that this is possibly caused by the prevalence of corruption in Nigeria's public health sector. In addition to this, Eboh, Abba, & Fatoye, using OLS, found that an increase in public health expenditure by 10% (they used health recurrent expenditure and health capital expenditures as their independent variables) decreased infant mortality rate by 1.34-1.54%.

Novignon & Lawanson (2017) and Arthur & Oiakhenan (2017) explored this relationship in Sub-Saharan Africa. Both studies found that public health expenditure improved health outcomes, although the changes were inelastic. Novignon & Lawanson used panel data from 45 countries from 1995 to 2011 and found that increasing health expenditure decreased infant mortality by 0.11, under-five mortality by 0.15, and neonatal mortality by 0.08. They found that public expenditures were more significant than private expenditures and thus recommended that governments boost public expenditures on health. Arthur & Oiakhenan found that public health expenditure significantly affected reduction in infant mortality rates, while private health expenditure significantly improved life expectancy at birth. The authors endorsed increasing public health expenditure to reduce the burden of private health expenditure on the people.

2.2. Synthesis and Gaps

There is a lack of studies that specifically assess how public expenditures affect malnutrition in the world and the Philippines. However, some studies concentrate on the role of governments and public expenditure on health outcomes (primarily using infant mortality rate as the dependent variable). The literature produced varying results. Some found that increasing public expenditure does not only significantly affect public health outcomes but also argues that it is crucial to do so, while some found that the effect of public expenditure on health outcomes is contrary to the prevailing notion, i.e., public expenditure improving health. In the Philippine context, the available studies point out the importance of the local government units in combating malnutrition. The LGUs are crucial mainly because they are the ones who do the legwork of the nutrition plans formulated by the national government (DOH and NNC). Their main objective is to implement and improve programs that would further attract participation from their constituents.

In summary, the literature emphasizes the crucial role public expenditure plays in reducing malnutrition. However, although highly desirable, public expenditure alone is insufficient; it must be accompanied by solid programs to be deemed effective. In addition to this, good leadership and a strong political will must also be present for these programs to come to fruition and bear beneficial results.

As mentioned, there is a lack of studies examining the impact of government expenditure on malnutrition. The available studies focus on the relationship between public health expenditure and public health in general. However, there are no recent studies, both foreign and local, that quantitatively investigate the effectiveness of government action on malnutrition rates. In the Philippine context, studies on malnutrition (particularly in line with government intervention) lack robustness. The available studies are qualitative, mainly reporting malnutrition occurrences in the country. On the other hand, the available quantitative studies focus on different determinants of malnutrition (e.g., climatic, topographic, social); there are no studies that examine the subject matter through an economic lens.

The lack of empirical studies on malnutrition in the Philippines drives the need to conduct more studies on the subject matter. This study, therefore, contributes to the literature by analyzing the effectiveness of government intervention in eradicating malnutrition. To the best knowledge of the researchers, this is the first study that tests this relationship comprehensively by employing econometric techniques.

2.3. Theoretical Framework

This study is anchored on Grossman's (1972) model of health demand from his seminal work, "On the Concept of Health Capital and the Demand for Health." Grossman postulated that an individual's health could be considered as a form of capital good influenced by different factors. The Grossman model can be summarized with the simple health production function:

$$H = f(X) \quad (1)$$

Where H is the individual health output, and X is a vector of individual inputs in the health production function. X is composed of factors such as initial genetic endowments, income, education, engagement in health-generating activities (e.g., medicine intake, medical care), subsequent individual choices (e.g., exercise, diet, smoking), and exogenous determinants.

Since this theoretical model is intended for individual-level analysis, and this study is constrained at the provincial-level analysis, the researchers adopt Fayissa and Gutema's (2005) version of the Grossman model in their study, "Estimating a health production function for Sub-Saharan Africa." The mentioned authors created a health production function that analyzes the relationship between health outcomes and several variables using panel data of different Sub-Saharan African countries. The health production function uses health outcomes as outputs and economic, social, and environmental variables as inputs.

The researchers employ Fayisa and Gutema's health production function and adopt it in the context of nutrition, specified as follows:

$$H = f(Y, S, V) \quad (2)$$

Where H is the nutritional status of children, Y is a vector of economic variables, S is a vector of social variables and, V is a vector of environmental variables. Consequently, for the empirical analysis of this study, H is limited to stunting rates of children ages 0 to 5 years old, Y is limited to public health expenditure, S consists of food security and poverty incidence, and V is composed of the percentage of the urban population.

This health production function serves as a framework in assessing whether health investments by the state, along with other economic, social, and environmental factors, are associated with changes in malnutrition.

3 Methodology

3.1. Research Design

This study employs a quantitative-correlational research design. Correlational research aims to assess and measure the degree of relationship among the variables under examination. In this study, the researchers employed the Ordinary Least Squares regression method to measure the effect of public health expenditure and other variables significantly on malnutrition rates.

3.2. Variable Selection

Given the multidimensionality of the health production function employed, this study uses a variety of variables. The study uses the three anthropometric indicators of malnutrition, namely, stunting, underweight, and wasting rates. The explanatory variables of this study are subcategorized under economic, social, and environmental categories. The economic variables include the primary variable of interest, public health expenditure, the social variables include food security and poverty incidence, and the environmental variables include the level of urbanization. The inclusion of these specific variables was based upon their relationships with malnutrition as expounded by the literature and the limitations and availability of data.

3.3. Data Collection

The data used in this study were gathered from multiple sources. The data on stunting rates and food security rates were obtained from 2015 Updating National Nutrition Survey conducted by the Food and Nutrition Research Institute under the Department of Science and Technology (DOST-FNRI). Employing a multi-stage stratified sampling design, the NNS details the nutrition status of Filipinos and provides scientific data for future nutrition and development programs. Its extension, the Updating Survey of the Nutritional Status of Children and Other Population Groups, is conducted every 2 to 3 years, which provides additional information and also serves as the monitoring scheme for the implemented nutrition programs.

The data on public health expenditure were obtained from the LGU Fiscal Data, which reports the Total Current Operating Expenditure of LGUs in all regions, cities, and municipalities of the Philippines. More specifically, the data is under the Health, Nutrition, and Population Control part of the report, which also includes expenditure on other health-related matters. While it can be argued that this is not wholly representative of expenditure on nutrition-specific interventions since it contains expenditure on health-related matters aside from malnutrition, the lack of available data limits the researchers to utilize data from the BLGF-DOF.

Poverty incidence and the percentage of the urban population were all gathered from the Philippine Statistics Authority. The poverty incidence statistics were collected from the Full Year Official Poverty Statistics; while, the percentage of the urban population data was gathered from the 2015 Census of Population and Housing.

Table 1 summarizes the variables used in this study, including the formal definition and the data sources.

Table 1. Summary of the variables

Variable	**Formal definition**	**Data source**
Stunting, *STU05*	The proportion of underheight/stunting among children, 0 to 5.0 years old (0 to 60 months), using WHO-CGS height-for-age	Updating National Nutrition Survey, DOST-FNRI
Underweight, *UND05*	The proportion of underweight among children, 0 to 5.0 years old (0 to 60 months), using WHO-CGS height-for-age	Updating National Nutrition Survey, DOST-FNRI
Wasting, *WST05*	The proportion of thinness/wasting among children, 0 to 5.0 years old (0 to 60 months), using WHO-CGS weight-for-height	Updating National Nutrition Survey, DOST-FNRI
Public Health Expenditure, *PHE*	LGU expenditure on Health, Nutrition, & Population Control	LGU Fiscal Data for All Provinces per Province, DOF-BLGF
Food Security, *FS*	The proportion of food secure households	Updating National Nutrition Survey, DOST-FNRI
Poverty Incidence, *PI*	The proportion of families/individuals with per capita income/expenditure less than the per capita poverty threshold to the total number of families/individuals	Full Year Official Poverty Statistics 2015, PSA
Percentage of the urban population, UP	Percentage of the population residing in urban areas	2015 Census of Population and Housing

3.4. Data Transformation

Since the study uses data gathered from different sources, some data estimates and the manner in which they are gathered are inconsistent. Because of this, necessary transformations were performed.

As mentioned in the previous section, the LGU Fiscal Data tallies the expenditure and income of all LGUs in the Philippines. The problem is that the data is disaggregated into the provincial, city, and municipal data, which indicates that the provincial data for health expenditures are not representative of the entire province because it does not include the health expenditures of the LGUs in their respective cities and municipalities. To amend this and obtain a single provincial estimate, the researchers added the health expenditures of cities and municipalities to their respective provinces. More specifically,

$$PHE = PHE_{province\ i} + PHE_{city\ at\ province\ i} + PHE_{municipality\ at\ province\ i} \qquad (3)$$

Some data sources also disaggregated cities from their respective provinces. Urbanization rate data from the 2015 Census of Population and Housing were also transformed because capital cities of some provinces were excluded in the estimation. For instance, the data of Benguet is separate from its capital city, Baguio; i.e., Benguet and Baguio have different data estimates.[2]. To obtain a single provincial estimate of the urbanization rate, the researchers applied the following formula:

[2] Such is also the case for the following provinces and cities: Pampanga and Angeles City, Zambales and Olongapo City, Quezon and Lucena City, Palawan and Puerto Prinsesa City, Iloilo and Iloilo city, Negros Occidental and Bacolod City, Cebu and the cities of Cebu, Lapu-lapu, and Mandaue, Leyte and Tacloban City, Zamboanga del Sur and Zamboanga City, Lanao Del Norte and Iligan City, Misamis Oriental and Cagayan de Oro City, Davao del Sur and Davao City, South Cotabato and General Santos, Agusan del Norte and Butuan.

$$\left(\frac{Urban\ Population_{city} + Urban\ Population_{province}}{Total\ Population_{city} + Total\ Population_{province}}\right) \times 100 \quad (4)$$

All necessary data transformations were performed in Microsoft Excel.

3.5. Econometric Model

In order to proceed with estimation, equation (2) is respecified as an econometric model given by:

$$H_i = \phi + \alpha Y_i + \beta S_i + \gamma V_i + \varepsilon \quad (5)$$

Where:

H_i = a vector of the three malnutrition indicators: underweight, stunting, and wasting rates at province *i*;
Y_i = a vector of economic variables composed of public health expenditure (PHE) and CPI of food and non-alcoholic beverages (CPI) at province *i*;
S_i = a vector of social variables composed of food security (FS) and poverty incidence (PI) at province *i*;
V_i = a vector of environmental variables composed of population density (PD) and urban population percentage (UP) at province *i*;
φ = the intercept term, which Grossman postulates as the initial health stock measuring the health status in the absence of health depreciation and health improvements brought about by economic, social and environmental changes;
α, β, γ = vectors of parameters for the economic, social, and environmental variables, respectively;
ε = the error component term

3.6. Statistical Tests

The primary aim of this study is to determine the effect of public health expenditure on the reduction of malnutrition prevalence in the country. More specifically, this study aims to quantitatively measure the change in malnutrition rates given a change in public health expenditure. In order to meet this objective, the study employs the Ordinary Least Squares (OLS) regression method. OLS regression evaluates the relationship between one or more independent variables and a dependent variable by minimizing the residual sum of squares (Gujarati, 2004). This method also determines whether a variable significantly affects the dependent variable as denoted by the t-ratios or p-values accompanying the coefficients of their respective variables.

All statistical tests were performed in the econometric software, Gretl.

A. Tests for individual coefficients

The coefficients determine the change in the dependent variable/s associated with a one-unit change in the independent variable/s, holding other variables constant. In this study, the coefficients measure the change in malnutrition rates with respect to a unit change in each exogenous variable, holding the other variables constant. Through this, the researchers are able to quantify the effect of one unit (one million) change in public health expenditure on malnutrition rates. The coefficients are tested for significance at the 1%, 5%, and 10% significance levels.

B. Goodness of Fit

In this study, the R^2 and Adjusted R^2 are used to measure the Goodness of Fit of each model. The R^2 measures the proportion of the variance of the dependent variable that is explained by the independent variables in a regression model. The Adjusted R^2 performs the same function but explicitly takes into account the number of independent variables included in the model. In addition to these, the overall significance of the model can be statistically tested through the F-statistic, which can be obtained by dividing the variance explained by the model on the unexplained variance (residual of error). Through these, the researchers are able to determine how well the constructed model is in explaining malnutrition prevalence in the Philippines.

C. Diagnostic tests

For the OLS parameters to yield the best, linear, and unbiased estimators, certain assumptions about the model must be satisfied. The following diagnostic tests were conducted to assess whether the assumptions of the Classical Linear Regression Model (CLRM) hold: White's test for heteroscedasticity, the Variance Inflation Factor to test for multicollinearity, and the Jarque-Bera normality test to assess the normality of the error term, and the Ramsey RESET test to assess possible misspecification.

a. White's Test

Given the cross-sectional nature of the data employed, the model is prone to heteroscedasticity—a situation wherein the error terms have unequal variance, inflating the variance of coefficient estimates and thereby affecting the overall statistical significance of the coefficient. White's test for heteroscedasticity was employed to determine the possible presence of heteroscedasticity—the null hypothesis of this test states homoscedasticity. Yielding a p-value greater than the level of significance would imply that the null hypothesis of homoscedasticity is accepted. Contrarily, a p-value less than 0.05 implies that heteroscedasticity is present.

b. Variance Inflation Factor

Since the independent variables under consideration are theoretically associated with one another, it is best to obtain the Variance Inflation Factor to test whether multicollinearity exists among the independent variables. Multicollinearity, a phenomenon where a high level of correlation between the explanatory variables exists, decreases the accuracy and reliability of coefficients. The rule of thumb states that if VIF values are greater than ten, the independent variables are highly correlated with each other.

c. Jarque Bera test for

The Jarque-Bera test is employed to gauge if residuals from the model are normally distributed. Though optional, ascertaining that the residuals are normally distributed ensures that the generated confidence intervals are reliable. In this test, the null hypothesis states that the error terms are normally distributed, which will be accepted if the p-value yielded is greater than the level of significance.

d. Ramsey RESET test

One of the assumptions of the CLRM is that the model must have no specification bias that may occur from omitting variables, selecting incorrect functional forms, among others. There are informal ways to detect this, but the study employs the Ramsey RESET test to formally test whether the models constructed are free from misspecification. Like the previous tests, accepting the null hypothesis by having a p-value larger than the level of significance implies that the model is correctly specified.

4. Results and Discussions

This chapter endeavors to meet the study's objectives raised in the introduction. It is divided into two main sections. In the first section, the general descriptive statistics of each variable are presented to get an overview of the data used, and the second section presents and analyzes the results of the OLS estimation, where the study's objectives are satisfied.

4.1. Descriptive Statistics

Table 1 shows the general descriptive statistics from the 75 provinces (including the four districts of NCR) of the Philippines in 2015.

Table 2. Descriptive Statistics

Variable	n	Mean	Std. Dev.	Min	Max	Skewness
UND0-5	79	22.75	7.44	7.10	41.3	0.29
STU0-5	79	35.88	8.55	15.9	59	0.1
WST0-5	79	7.24	3.21	0	16.9	0.78
PHE	79	989.03	1325.96	34.3	7520.5	2.90
FoodSec	79	32.03	9.41	7.7	58.4	0.34
PovInc	79	29.43	17.40	1.2	77.1	0.34
UrbPop	79	35.57	26.65	2.5	100	0.89

Note: these estimates differ from national estimates because some provinces were omitted.

In 2015, about 22.75% of under-five children were underweight. Ilocos Norte had the lowest prevalence with only 7.1% being underweight; while, Biliran contains the most populace of underweight children with 41.3%. Stunting is more prevalent than the other two malnutrition indicators, with it having the highest mean and standard deviation of 36.07% and 8.53, respectively. The lowest stunting rate of 15.9% in Bataan contrasts with the highest stunting rate of 59% in Catanduanes. In contrast to these, wasting

is less prevalent in the Philippines during 2015, ranging only from 0 to 16.9%, implying that wasting is not as widespread as the two indicators.

The average public health expenditure of the Philippines in 2015 was around 989.03 million pesos, with a standard deviation of 1325.96. The province with the lowest expenditure on health is Tawi-tawi, with only 34.33 million pesos invested in health, contrasting Laguna, which spent 7.521 billion pesos on health-related endeavors. It is important to note that Laguna comprises several highly urbanized cities that allot generously on their health investments. The difference between the lowest and highest values is large, signifying the great variation in health expenditure among provinces in the Philippines. In addition, public health expenditure has a skewness of 2.90, which is highly skewed to the right according to Bulmer's (1987) rule of thumb. The high variability and skewness imply that some provinces invested much higher in health than others.

On average, only one out of three households, or 32.03%, were food secure in 2015. The least food secure province is Lanao del Sur, with only 7.7% of its households meeting adequate food requirements. In contrast, Bataan has the highest tallied food secure households with 58.4%. The average poverty incidence rate in 2015 was 24.11, suggesting that almost one out of four households lived on incomes lower than the poverty threshold. Interestingly, the difference between the highest and lowest poverty rates is significantly high. This observation exposes the extremities of poverty, as some provinces have notably higher degrees of poverty than others. In particular, Bataan has the lowest poverty incidence rate with 0.8%, while Lanao del Sur has the highest poverty incidence rate of 72.4%. It is interesting to note that Lanao del Sur, the least food secure province, also has the highest poverty incidence rate. At the same time, Bataan is the most food secure and has the lowest incidence of poverty among all provinces in the Philippines. This observation hints at the indirect relationship between food security and poverty[3].

The level of urbanization is highest in NCR, with each district, all composed of highly urbanized cities, having an urbanization rate of 100%. On the other hand, the least urbanized province is Ifugao, with an urbanization rate of 2.5%.

4.2. Regression results

In this section, the researchers endeavor to meet the objectives of the study by presenting and analyzing the results from the OLS estimation. To recap, this study primarily aims to measure the effect of public health expenditure on malnutrition rates and determine whether their relationships are statistically significant. Further, the study seeks to assess how the chosen variable, food security, poverty incidence, and level of urbanization, also affects malnutrition rates.

Table 2 presents the results from the OLS estimation, which are organized into three panels. Panel A presents the coefficient of each corresponding variable, which determines the change in the dependent variables given a one-unit change in each independent variable, holding other variables constant. Panel B presents the Goodness of Fit, measuring how well the constructed model fits the data of each anthropometric indicator. Lastly, Panel C shows the results from the diagnostic tests that examine whether certain assumptions of the CLRM are met. The results will be presented in an inverted manner, beginning from Panel C to Panel A.

Table 3. OLS Estimates

	STU0-5	**UND0-5**	**log_WST0-5**
Panel A			
Intercept	30.3092***	27.0553***	2.0922***
	(4.1390)	(4.6716)	(0.3087)
PHE	-2.8508e-06	0.0001	2.6627e-05
	(0.7396)	(0.0007)	(4.4943e-05)
FoodSec	-0.1910**	-0.1392	0.0014
	(0.0908)	(0.1024)	(0.0069)
PovInc	0.2131***	0.0723	-0.0040

[3] Given the apparent relationship between the two variables, the VIF value of each variable was obtained to determine whether multicollinearity is present. The VIF, along with other diagnostic tests, will be discussed in 4.2.

	(0.0524)	(0.0591)	(0.0038)
UrbPop	-0.0725** (0.0330)	-0.0593 (0.0372)	-0.0040* (0.0024)
Panel B			
No. of Obs	79	79	78
R^2	0.5196***	0.1911***	0.0426
Adj. R^2	0.4936	0.1473	-0.0099
F	20.0083	4.3699	0.8112
Panel C			
White's Test	0.8782	0.2597	0.2917
Jarque-Bera	0.5425	0.2991	0.3379
Ramsey RESET	0.3273	0.2588	0.7555
VIF		FoodSec = 1.528 PovInc = 1.736 UrbPop = 1.736 log_PHE = 1.532	

Notes:
**** p < 0.01, ** p < 0.05, * p 0.1.*
Standard errors in parenthesis.
Values in Panel C are p-values. VIF are Centered VIF values for each independent variable.

A. Diagnostic Tests

Before proceeding with the regression results, it is necessary to check whether CLRM assumptions hold to ensure that the models produce robust results. In this study, the researchers employed four diagnostic tests: White's test for heteroscedasticity, Variance Inflation Factor (VIF) to test for multicollinearity, Jarque-Bera test for normality of residuals and the Ramsey RESET test for misspecification.

Given the results from Panel C, all p-values for all tests are greater than 0.1, signifying that assumptions pertaining to the correct specification, normal distribution of errors, and homoscedasticity hold true. As for multicollinearity, the VIF values are all less than ten, implying that there is no multicollinearity in all models.

With all CLRM assumptions being met in all models, the estimates produced from the OLS, presented in the following subsections, are said to be the best, unbiased linear estimators (BLUE).

B. Goodness of fit

In Panel B, the Goodness of Fit (R^2) and F-statistic of each model are presented, which shows the fit of the constructed model on the three anthropometric indicators and the overall statistical significance of each model.

The yielded R-squared values for the stunting, underweight, and wasting models are 0.51, 0.19, and 0.04, respectively. These demonstrate the weakness of the constructed model since the variance in the malnutrition rates that the model can explain is less than 50%. Admittedly, the researchers failed to include certain variables in the analysis because of certain limitations. However, the model's weakness can also be used to make a case on how complicated and diverse the problem of malnutrition is. From another perspective, there are other–and presumably a multitude of–factors that explain the rest of the variation in malnutrition rates. The low R-squared values suggest that the few chosen variables do not solely encapsulate the severity of malnutrition, further

demonstrating that malnutrition is affected by a set of heterogeneous factors that cannot be simply determined. Likewise, there may also be other factors that are difficult to quantify or may fall outside the study's theoretical framework. For instance, cultural and traditional practices, political instability, and warfare are linked to consumption patterns but are challenging to consider in a regression model explicitly.

C. Determining the effect of food security, poverty incidence, and level of urbanization on malnutrition rates

This subsection discusses the coefficients found in Panel A. In particular, the coefficient estimates of the social and environmental variables, i.e., food security, poverty incidence, and level of urbanization, are presented and analyzed. In this section, the researchers fulfil the second objective of this study, which is to determine the effect of the aforementioned variables on malnutrition rates.

In the first model, food security, poverty incidence, and urbanization rate follow their expected signs and are statistically significant, suggesting that these variables influence stunting. The results suggest that increasing food-secure households by 1% decreases stunting prevalence by around .19%, other things held constant. This result corroborates the existing notion that the ability of an individual or household to access safe and nutritious foods dictates their nutritional status. Further, an increase of 1% in poverty incidence increases stunting rates by .21%; others held constant. Poverty incidence is directly related to stunting, which follows the apparent notion that malnutrition is well-tied with poverty. Having an income below the poverty threshold severely limits an individual's ability to procure his or her basic necessities.

The level of urbanization also statistically affects stunting. If a province's level of urbanization increases by 1%, stunting rates decrease by about 0.07%. This finding supports the a priori assumption that as provinces progress in terms of urbanization, people would be better situated nutritionally because they would have better access to safe drinkable water and sanitation facilities, better health services due to proximity of health facilities, and better economic opportunities, which would consequently improve their overall diet. This finding corroborates existing studies that find that child nutritional outcomes are better in urban areas than in rural areas of developing countries (see Amare et al., 2020). However, it is notable that the coefficient of the urbanization rate is much smaller compared to the other two variables mentioned above. This may imply that even though urbanization improves access to better diets, it will not necessarily reduce malnutrition absolutely. This is evidenced by a considerably high degree of malnutrition prevalence in urban areas like Metro Manila.

In the second model, underweight rates were used as the dependent variable. Notable from the results is that all variables have statistically insignificant relationships with underweight. The results can be better understood if the yielded R^2 from the model is taken into the analysis. The low R^2 value signifies that there are excluded variables that could better explain the variance in underweight rates. For instance, one key determinant of a child's weight is genetics. If both parents are underweight, it is highly likely that the child may become underweight, as well (NCBI, 2004). A child may belong to an affluent and food secure household living in an urban area; however, the biological make-up of the parents would ultimately determine the weight of a child. Aside from these, there are also factors affecting weight that fall under categories of prenatal factors, maternal factors, or race/ethnicity factors. But since these individual-specific factors are incompatible in the macro-level analysis of the study, these were intendedly set aside. Hence, because of such factors, it becomes apparent how macro-level factors in the model become statistically insignificant. These results do not imply, however, that food security, poverty incidence, and level of urbanization do not affect a child being underweight. This implies that further inclusion of different variables is necessary to produce better and more accurate results.

The third model with wasting rates as the dependent variable is an interesting case. The model produced contrasting results from a priori expectations. That is, aside from the statistically significant urbanization rate, all other independent variables have contradicting signs and are all statistically insignificant. These results cannot be interpreted as they are and may just be an empirical phenomenon, considering the fact that the overall model does not fit well with wasting rates. The model produced a very low R-squared of 0.04, which implies that the model does virtually nothing to explain the variation in wasting rate. Furthermore, the whole model is statistically insignificant, with its p-value larger than all significance levels. The underlying reason behind this might be associated with the lack of variation in wasting rates. As previously explained, not all provinces had high wasting rates, with some provinces even having almost none. Compared to stunting and underweight rates, wasting is sporadic and may only occur in extreme and specific conditions that the model does not address. These results show that the factors affecting wasting differ from those of stunting and underweight rates, implying that wasting is a unique phenomenon that needs to be studied more extensively.

D. Measuring the effect of public health expenditure on malnutrition rates

This subsection discusses the coefficients of public health expenditure, still on Panel A. This focuses on addressing the primary objective of the study: quantifying the effect of public health expenditure on malnutrition rates and determining whether a statistically significant relationship exists between them.

In all three models, the findings show that the effect of public health expenditure on all malnutrition is virtually zero. Translated literally, if provinces increase their investment in health by one million pesos, there would be almost no change in malnutrition rates since the coefficient is near zero. Additionally, all coefficients are statistically insignificant, with their p-value greater than the significance levels. Thus, the alternative hypothesis postulating a significant relationship between public health expenditure and malnutrition indicators cannot be accepted.

As interesting as these are, the results are not surprising considering the historical trend of malnutrition shown in Figure 1 in the first chapter. From Figure 1, it can be seen that there have been little to no changes in all malnutrition indicators for the past two decades. This figure alone shows that the problem has not been thoroughly addressed by concerned authorities. With the constant malnutrition trends paired with the finding that the PHE coefficient is nearly zero, one can infer that government expenditure on health has not been effective in mitigating malnutrition prevalence. To further support this claim, also consider that not all provinces treat malnutrition as a priority concern. As Herrin et al. (2017) explains, there has been significant progress in addressing other health-related concerns; however, development in malnutrition reduction remains limited, as evidenced by the lack of prioritization on malnutrition-specific interventions of LGUs. If there is an absence of prioritization and political will to address the problem, then any additional expenditure on health would be rendered ineffective.

These results do not imply, however, that public expenditure is unnecessary in mitigating malnutrition. On the contrary, quoting a study from the World Bank (2020), "nutritional interventions are one of the most cost-effective investments for human capital" since they are highly affordable and bear significant returns on investment. However, it is essential to note that public expenditure is insufficient in and of itself. Alongside improving investments in nutrition, the concerned authorities must acknowledge the severity of malnutrition and muster the political will to address the problem.

5. Conclusion

The primary aim of this study is to measure the relationship between public health expenditure in order to assess whether they are effective in reducing malnutrition prevalence of children aged below five in the Philippines. The researchers employed a health production function based on the Grossman model to estimate how different economic, social, and environmental factors affect malnutrition rates of children below five. Multiple regression analysis via OLS was employed to meet the study's objectives.

OLS estimates reveal that public health expenditure has virtually no effect on malnutrition rates of children, which implies that budget allocation by the state on malnutrition-reduction initiatives has been inefficient and ineffective. This is further supported by empirical data showing that the trend of malnutrition has remained stable over the decades because the problem has been ineffectively addressed by the government. In addition to this, the researchers found that increasing food security, decreasing poverty, and improving overall urbanization significantly reduce stunting. These results imply that reducing malnutrition requires addressing it from problems rooted in socioeconomic and environmental factors. However, the aforementioned variables do not have a statistically significant relationship with underweight and wasting prevalence, which signifies that there are other factors that affect these types of malnutrition more than the variables included in the study.

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