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DIFFERENTIAL IMPACT OF RESIDENTIAL SECTORS ON THE PREVALENCE OF CHILD MALNUTRITION IN SRI LANKA

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ABSTRACT

Child malnutrition continues to be a significant global public health challenge, with serious consequences on both social and economic progress. It can lead to stunted growth and low cognitive development which can have long-term impacts on their future. In Sri Lanka, child malnutrition manifests differently across urban, rural, and estate residential sectors, with each area facing unique challenges. This research aims to investigate the differential impact of residential sectors on child malnutrition in the Nuwara-Eliya district. This research was based on primary data and a sample survey was conducted for data gathering using a questionnaire. The sampling method adopted to choose the sample was multi-stage stratified sampling. The sample size, determined using the Krejcie–Morgan table, consisted of 378 participants. The sampling unit was children enrolled in grade 6 at government schools in the Nuwara-Eliya district. The study's analysis involved the application of descriptive statistics and binary logistic regression model. Descriptive statistics revealed that the highest prevalence malnutrition among school children has recorded in the estate sector in both aspects of underweight (34%) and stunting (37%). However, in terms of wasting, urban sector recorded the highest malnutrition (33%). Binary logistic model found a statistically significant impact of residential sectors on child malnutrition in the aspect of underweight. P value of Hosmer–Lemeshow test statistics is greater than 0.05 and it justifies the selected logit model for malnutrition in terms of underweight is sufficiently fit with data. The probabilities of being malnourished are 0.16, 0.30 and 0.50 in the rural, urban and estate sectors respectively. Understanding these differential sectorial impacts, with a particular focus on the unique challenges faced by children in different sectors is important for a comprehensive approach to combat malnutrition focusing the sectorial disparities and to develop effective involvements to enhance child nutrition and health outcomes.

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1. INTRODUCTION

Child malnutrition is a critical public health issue that has long-term consequences not only on the physical and cognitive growth of children but also on the socio-economic status of communities and nations. From a theoretical perspective, undernutrition and overnutrition are two main types of malnutrition (Das and Gulshan, 2017). Undernutrition is characterized by an insufficient intake of essential nutrients, including proteins, calories, or micronutrients. Undernutrition is recognized as a condition resulting from inadequate nutrition, either due to decreased food intake or impaired metabolic processes and evaluating nutritional status is crucial for assessing the extent of undernutrition (Bhattacharya et al., 2019).

Malnutrition continues as a non-ending circle (Khalid et al., 2017), as given in Figure 1.

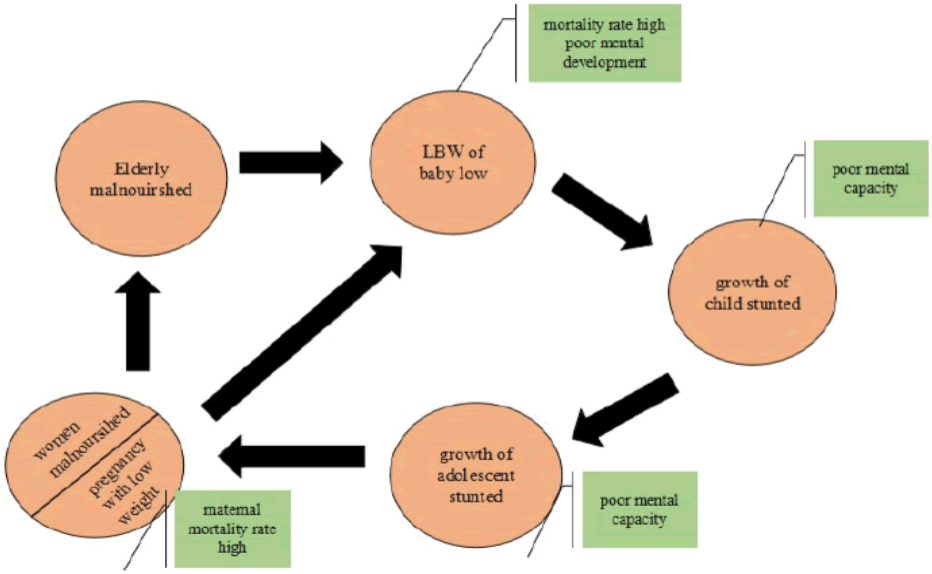

Figure 1: Cyclical process of malnutrition
Source: Khalid et al. (2017)

When mothers suffering from malnutrition deliver babies with low birth weight, these babies often grow into malnourished children, facing ongoing challenges due to various factors. As their growth remains stunted, these children become malnourished adolescents. For girls, this cycle perpetuates malnutrition during their future pregnancies, increasing the probability of delivering low birth weight babies. Thus, the cycle of malnutrition is passed on from generation to generation, continuing throughout their lives.

Anthropometric indices commonly used to assess undernutrition include Weight For Age (WFA), Height For Age (HFA), Weight For Height (WFH), Body Mass Index (BMI), Mid Upper Arm Circumference (MUAC), and Birth

Weight (Casadei & Kiel, 2021). The three main forms of undernutrition, wasting, stunting, and underweight are assessed using WFH, HFA, and WFA Z scores, respectively (World Health Organization [WHO], 2010). The WHO considers a child as undernourished when any one of these indices fall lower the two standard deviations (>-2SD) from the WHO defined child growth standard median (WHO, 2010).

Child malnutrition is disproportionately affecting children in developing regions. The causes problem are multifaceted, ranging from inadequate dietary intake to poor healthcare and sanitation. One key factor often discussed in literature is the impact of residential sectors urban, rural and estate, on child malnutrition. Worldwide, child undernutrition appears as a significant issue, since 144 million of children under the age of 5 years are counted to be stunted. Additionally, 47 million are reported to be wasted approximately, and 14.3 million are severely wasted (WHO, 2020). The incidence of malnutrition differs from one region to another and one country to another and the issue is more serious in countries that belong to developing category (Ladu et al., 2018).

Table 1: Incidence of child malnutrition by region and country in 2020

Region	**Malnutrition % (Stunting)**	**Countries**	**Malnutrition % (Stunting)**
African	31.7	Afghanistan	35.1
American	8.9	Bangladesh	30.2
South-East Asia	30.1	India	30.9
Eastern Mediterranean	26.2	Nepal	30.4
Europe	5.7	Bhutan	22.4
Western Pacific	9.3	Pakistan	36.7
		Sri Lanka	16

Source: UNICEF / WHO / World Bank Group, 2021

According to Table 1, classification of WHO reveals that the African region has the highest stunting rate among children under five, at 31.7%. The South-East Asia region also reports a significant stunting rate of 30.1%. In South Asia, where population density is high, stunting rates are notably elevated. Pakistan has the highest rate of stunting with a recording 36.7%. Other countries in the South Asian region, including Sri Lanka, also experience substantial levels of stunting (UNICEF / WHO / World Bank Group, 2021).

Table 2: Child malnutrition in Sri Lanka by district

District	**Percentage below** -3 SD	**Percentage below** -2 SD	**District**	**Percentage below** -3 SD	**Percentage below** -2 SD
Colomb	4.3	15.6	Killinochchi	6.6	20.9
Gampa	2.9	12.8	Batticaloa	3.6	20.6
Kalutar	1.7	12.5	Ampara	7.2	21.9

Kandy	5.2	26	Trincomalee	3.5	15.5
Matale		14	Kurunegala	2	17.7
Nuwara Eliya	10	32.4	Puttalam	2.9	11.7
Galle	3.7	12.5	Anuradhapur	5.9	19.1
Matara	3.8	15.6	Polonnaruwa	3	11.1
Hamba	2.6	11.8	Badulla	6.5	20.6
Jaffna	1.5	13.7	Monaragala	3.5	15.9
Mannar	4.6	20.8	Rathnapura	4	17.8
Vavuni	6.1	18.7	Kegalle	8.4	23.1
Mullati	6	16.7			

Source: Department of Census and Statistics, 2017

As shown in Table 2, according to the Department of Census and Statistics (DCS) (2017), the occurrence of child malnutrition, in terms of stunting by district in Sri Lanka, remains at a considerable level.

Nuwara-Eliya has recorded the highest proportion of malnutrition in the aspect of stunting (Height-For-Age) (HFA), at 32.4%, and 10% falling below -2 SD and below -3 SD, respectively (Department of Census and Statistics [DCS], 2017). Child malnutrition remains a significant public health issue in Sri Lanka, despite the country's advances in healthcare and education. Within this context, the Nuwara-Eliya district, a region known for its tea plantations, presents a unique case study in understanding how residential sectors, particularly urban, rural and estate settings affect malnutrition among school children. Each of these residential sectors has distinct socioeconomic and environmental characteristics, and their differential impact on child malnutrition is a critical area of research. Identifying the differential impact of geographical regions on child malnutrition is important for developing strategies for fighting against it. Research on identifying differential impact of residential sectors on child malnutrition is limited in Sri Lanka, particularly among school children. Without a deeper understanding of the differential impact of residential sectors on malnutrition among school children, it is unlikely that a healthy nation can be achieved in regions with sectorial variation. Achieving a healthy nation in regions with sectoral disparities is hard without a deeper understanding of the differential impact of residential sectors on malnutrition among school children. This study focuses on examining the differential impact of residential sectors on malnutrition prevailing among school going children in Sri Lanka with special reference to the Nuwara-Eliya district. The research outcomes will support health authorities to address sectoral disparities in reducing child malnutrition more effectively with a particular focus on the unique challenges faced by children in different urban, rural and estate areas.

2. LITERATURE REVIEW

2.1 Malnutrition in global context

Globally, malnutrition among children is a major concern, with both undernutrition and the rising incidence of overweight and

obesity (the double burden of malnutrition) presenting significant public health challenges. The WHO, 2020 defines malnutrition as deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients. For school-aged children, malnutrition can manifest as stunting (low height for age), wasting (low weight for height), being underweight or being overweight, all of which have lasting impacts on physical and cognitive development (Black et al., 2013). A significant body of literature highlights the disparities in the prevalence of child malnutrition among different regions. Many studies have emphasized that children in rural areas tend to suffer from higher rates of malnutrition compared to their urban counterparts. However, many other studies have found that the highest malnutrition is continuing in the estate sector. Research across multiple countries consistently highlights those different regions experienced different malnutrition rates.

Kandala et al. (2011) established that geographical location plays a significant role in determining the nutritional status of children under five in the Democratic Republic of Congo. Their study analyzed spatial variations in malnutrition prevailing among young children through a geo-additive semi-parametric mixed model, which accounted for spatial dependence and nonlinear effects of covariates, employing a regression framework using Markov Chain Monte Carlo techniques. Likewise, Rahman and Chowdhury (2007) found that regional differences were closely tied to severe and moderate stunting. Similarly, Ayana et al. (2015) have identified a strong relationship between malnutrition, indicated by wasting, and the place of residence. Debnath and Bhattacharjee (2014) have also pointed out that place of residence, along with the wealth index, were key factors in determining child malnutrition. Magalhães and Clements (2011) mapped anaemia risk among nursery children in West African region and identified spatial differences in anaemia prevalence. They estimated the geographical risk outline of anaemia, considering factors like malnutrition and malaria, and reported that the occurrence of mild, moderate, and severe anaemia in Burkina Faso was 21%, 66%, and 13%, respectively, while in Ghana it was 28%, 65%, and 7%, and in Mali, it was 26%, 62%, and 12%. A significant cluster of low hemoglobin levels and high anaemia risk was predicted for areas shared by Burkina Faso and Mali. Endris et al. (2017) have also reported that living in certain regions of a country increased the risk of malnutrition.

According to Fagbamigbe et al. (2020), severe acute malnutrition was more common in rural regions than in urban regions in many of the countries. Das and Gulshan (2017) identified urbanization as a critical factor influencing stunting rates. Zhang et al. (2016) highlighted notable regional differences, showing that less urbanized regions had higher levels of undernutrition. In their study on malnutrition among primary school-aged children in Bahawalpur, Pakistan, Ali Khan and Azid (2011) have found out that children living in slums have more probability of suffering from anthropometric failure. Kandala et al. (2011) further proposed that malnutrition rates were significantly higher in rural areas compared to urban centers, even when adjusting for various factors. Ajieroh (2009) argued that improving nutritional and public health services in rural regions, particularly those with a high burden of malnutrition, could significantly enhance child and maternal nutrition.

As revealed by Habyarimana et al. (2016), provincial location was a crucial determinant of malnutrition among under five years children in Rwanda. Similarly, Kandala et al. (2011) demonstrated that malnutrition in children was more prevalent across several provinces in the Democratic Republic of Congo, particularly in mining areas and conflict-affected eastern regions. Chowdhury et al. (2018) identified that the Sylhet division in Bangladesh particularly at risk with severely underweighted children, emphasizing the role of geography in malnutrition. Khan and Mohanty (2018) used univariate Moran's I statistics to show spatial clustering of child malnutrition across districts in India, indicating that stunting, wasting, and underweight were spatially dependent and heterogeneously distributed.

Research across multiple countries consistently highlights that rural children tend to experience higher rates of undernutrition compared to their urban counterparts (Fotso, 2007). The reasons for this disparity are rooted in limited access to healthcare, poor sanitation, lower socioeconomic conditions, and food insecurity, particularly in agricultural-dependent rural areas. Urban areas, while typically offering better access to resources, are not immune to malnutrition. Urban poverty, especially in slum areas, contributes to significant malnutrition levels, often linked to food insecurity, poor living conditions, and exposure to unhealthy diets (Haddad et al., 2015). In many developing countries, urbanization has brought about the "nutrition transition," where dietary patterns shift from traditional, nutrient-rich foods to calorie-dense, processed foods. This shift is associated with the rise in obesity and diet-related non-communicable diseases (Popkin, 2002). Understanding these global patterns provides an important backdrop for analyzing malnutrition in the Nuwara-Eliya district, where distinct urban, rural and estate dynamics influence nutritional outcomes among school children. Despite the commonly held view that urban children are better off, research shows that children living in urban slums face similar, if not worse, malnutrition rates compared to rural children. According to a study by Frongillo et al. (2007), children in informal settlements often experience malnutrition due to overcrowded living conditions, poor sanitation, lack of clean water, and unreliable access to healthcare services. Furthermore, the urban poor frequently experience higher food prices compared to rural populations, leading to decreased affordability of nutritious foods (Baker & Friel, 2016). This urban paradox highlights how malnutrition can persist even within resource-rich urban settings, especially among marginalized communities. Various socioeconomic factors such as parental education, income, and employment have been identified as crucial determinants of child malnutrition in both urban and rural areas. A meta-analysis by Black et al. (2013) found that maternal education is strongly correlated with improved nutritional outcomes for children, as educated mothers are more likely to adopt better childcare practices and utilize healthcare services effectively. This trend is more pronounced in urban areas, where maternal education and employment rates are typically higher. Environmental factors, including access to clean water, sanitation, and healthcare infrastructure, also play a critical role in determining malnutrition outcomes. Studies show that inadequate sanitation and water quality are significant contributors to child stunting and

underweight in rural areas (Prüss-Üstün et al., 2019). These environmental issues are often exacerbated in rural settings where infrastructure development is lagging. However, urban areas, particularly slum communities, also suffer from similar infrastructural deficiencies, leading to comparable rates of malnutrition in some cases.

According to Smith et al. (2005), rural environments are often characterized by limited access to healthcare services, poor infrastructure, and lower socioeconomic conditions, which contribute to high levels of malnutrition. Rural households often rely on subsistence farming, where food insecurity is common, leading to insufficient dietary diversity and caloric intake for children (UNICEF, 2019). In contrast, urban areas are generally associated with better access to healthcare, education, sanitation, and a more diversified diet. For example, studies by Fotso (2007) and Monteiro et al. (2000) indicate that urban environments often present lower rates of child undernutrition due to better access to resources and services. However, this narrative is increasingly complicated by urban poverty, particularly in rapidly growing cities in developing countries, where slums and informal settlements harbor significant child malnutrition challenges (Haddad et al., 2015). Despite the commonly held view that urban children are better off, research shows that children living in urban slums face similar, if not worse, malnutrition rates compared to rural children. According to a study by Frongillo et al. (2007), children in informal settlements often experience malnutrition due to overcrowded living conditions, poor sanitation, lack of clean water, and unreliable access to healthcare services. Furthermore, the urban poor frequently experience higher food prices compared to rural populations, leading to decreased affordability of nutritious foods (Baker & Friel, 2016). This urban paradox highlights how malnutrition can persist even within resource-rich urban settings, especially among marginalized communities.

2.2 Malnutrition in the Sri Lankan context

In the Sri Lankan context, there have been significant strides in improving child health outcomes, yet malnutrition persists as a critical issue. According to the Sri Lanka Demographic and Health Survey (2016), 17% of children under five are stunted, 15% are underweight, and 15% suffer from wasting. These figures reveal persistent challenges, particularly in rural and estate sectors where poverty and food insecurity remain high (DCS, 2017). Malnutrition is further exacerbated by disparities in access to healthcare, education, and clean water, particularly in regions like Nuwara-Eliya. The Sri Lankan government has recognized malnutrition as a key public health challenge and implemented several programs to address it, such as the National Nutrition Policy and the Thriposha program, which provides fortified food supplements to pregnant women and young children. Despite these efforts, the estate sector continues to experience disproportionately high rates of child malnutrition (Jayawardena, 2014).

Several studies highlight the differential impact of residential sectors on child malnutrition in Sri Lanka, with a particular focus on the Nuwara-Eliya district. The primary disparity lies in the stark difference between the urban and estate sectors in terms of socioeconomic status, access to resources, and living conditions. Estate

sector, which houses the workers of Sri Lanka's tea plantations, is marked by poverty, poor living conditions, and limited access to healthcare and education, making it one of the most vulnerable populations in the country. The Nuwara-Eliya district, is unique due to its large tea plantation estates and the socioeconomically distinct populations that reside in the urban and estate sectors. The urban sector of Nuwara-Eliya benefits from relatively better infrastructure, healthcare, and education services compared to the estate sector. However, urban poverty, particularly among informal settlements, poses nutritional challenges for children in the urban areas (Karunaratne, 2011). The estate sector, on the other hand, is home to the majority of tea plantation workers, many of whom are of Indian Tamil origin and have historically faced marginalization. The living conditions in this sector are poor, with limited access to clean water, sanitation, healthcare, and education. The socioeconomic and environmental conditions in the estate sector are widely regarded as some of the worst in Sri Lanka, with poverty rates being significantly higher than the national average (Perera & Gunawardena, 2013).

In Sri Lanka, Jayatissa et al. (2008) found that severe stunting and wasting were more prevalent in the estate regions relative to urban regions, while Jayawardena (2015) reported the greatest incidence of low birth weight in the estate sector, with nearly one-third of babies born underweight. Children living in the urban areas of Nuwara-Eliya with higher rates of child malnutrition, as educated mothers are more likely to engage in better childcare and feeding practices (Perera & Gunawardena, 2013).

benefit from better access to healthcare facilities, schools, and nutrition programs. According to studies conducted by the Ministry of Health (2018), urban children in Nuwara-Eliya exhibit lower rates of stunting and wasting compared to those in the estate sector. Urban parents are more likely to have access to nutritional education and healthcare services, which positively impacts the nutritional status of their children (Jayatissa & Hossain, 2010). However, the rising cost of living in urban areas can lead to food insecurity among low-income families, contributing to malnutrition, especially in informal urban settlements. In contrast, children in the estate sector face significant challenges in terms of malnutrition. According to studies by the World Food Programme (WFP, 2016), the prevalence of stunting and wasting among children in the estate sector is substantially higher than in the urban sector. The key determinants of malnutrition in this sector include poverty, poor dietary diversity, limited access to clean water and sanitation, and inadequate healthcare services. Estate sector households are often isolated from urban centers, and tea plantation workers typically live in overcrowded and poorly ventilated housing known as "line rooms" (Mullerpierce, 2019). These conditions, combined with limited economic opportunities and a reliance on low-wage labor, contribute to food insecurity and poor nutritional outcomes among children (Edirisinghe, 2012). Moreover, maternal education levels are significantly lower in the estate sector, which correlates

Rathnayake and Weerahewa (2005) showed that the Sabaragamuwa Province had the highest rate of underweight children, followed by Uva Province. However, the North West Province ranked second in terms

of depth and severity of malnutrition. Jayawardena (2015) also noted that children living in the Eastern, Uva, and Central Provinces were at a higher risk of chronic malnutrition due to underdevelopment, poor access to healthcare, lower education levels, and cultural practices that negatively affected household nutrition. In contrast, children in the Western Province benefited from better access to facilities and health services. Jayatissa et al. (2008) additionally observed higher stunting rates in Nuwara Eliya than in the Colombo municipality area.

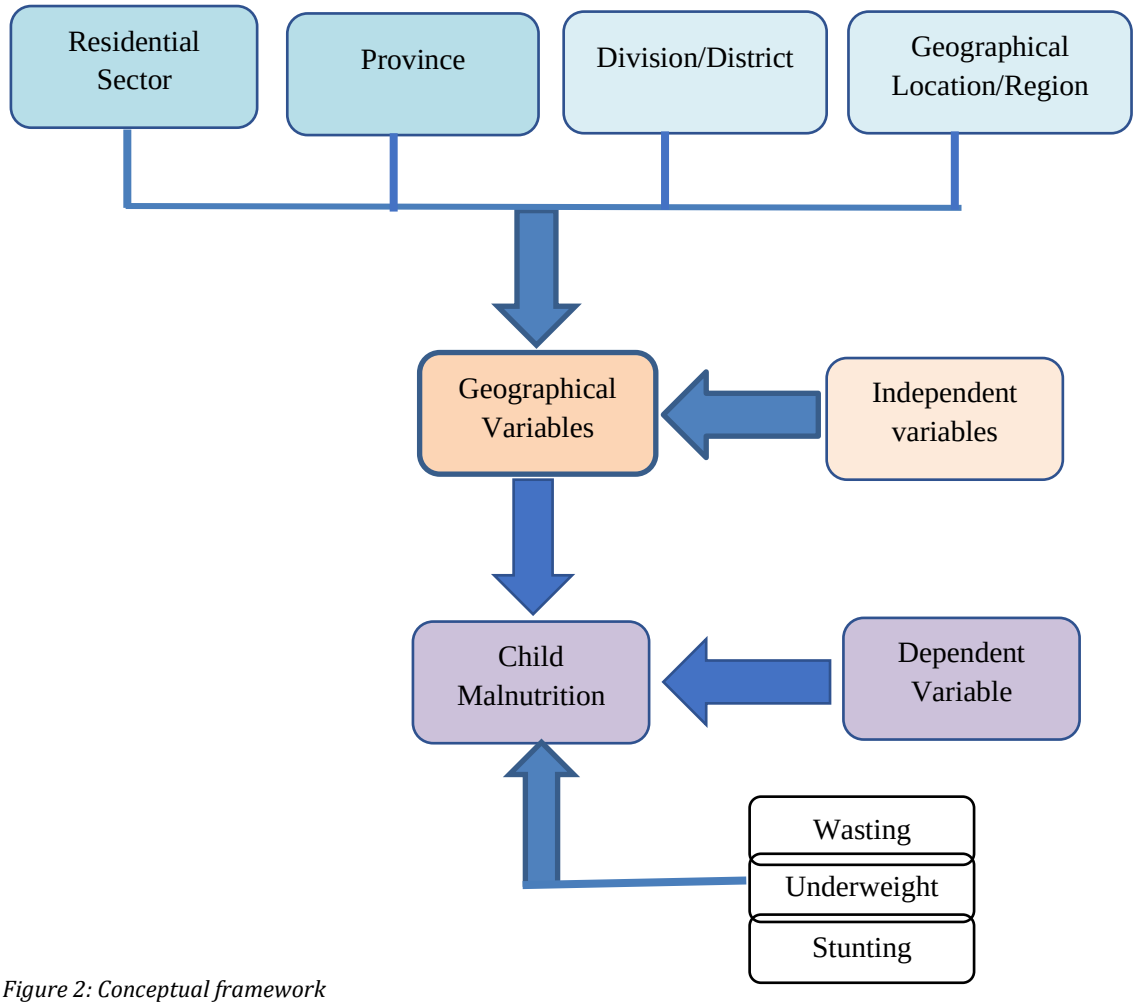

Figure 2: Conceptual framework
Source: Developed by the researcher, 2023

3. METHODOLOGY

This study mainly utilized primary data gathered through a sample survey. Nuwara-Eliya district was the study area selected for the research because of the highest prevalence malnutrition (32.4%) in term of stunting (DCS, 2017). The study used multi stage stratified sampling technique to select the sample from the target population of 12963 grade 6 government school children studying in the Nuwara-Eliya district. At the second stage, 3 schools from each types of schools (Type 1AB, Type1C, and Type 2) which hold grade 6 classes were selected randomly for the sample. Number of students selected for each type was decided based on proportional allocation method. At last, a sample of 378 grade 6 children representing both male and female were chosen for the survey. The sample size was determined using the Krejcie–Morgan table. A structured questionnaire was the instrument used for data collection. Approval for conducting the research was granted by the Ethics Review Committee of the University of Kelaniya, Sri Lanka. It was also agreed that the identities of both the children and the schools would remain confidential.

Table 3: Description of the modeled variables

Variables	Classification of variable			Measurement Scale
	Dependant (D) Or Independent (I)	Categorical (Binary)	Categorical (Multi-category)	
Malnutrition (Wasting)	D	√		Nominal
Malnutrition (Underweight)	D	√		Nominal
Malnutrition (Stunting)	D	√		Nominal
Residential Sectors	I		√	Nominal
GN Divisions	I		√	Nominal

Source: Developed by the researcher, 2023

Table 3 clarifies the dependent and independent variables used in this study with their types, and measurement scales. Three binary logit models were fitted to investigate sectorial impact on child malnutrition in the aspect of wasting, underweight and stunting separately. The dependent variables for three models are

wasting, underweight and stunting measured through Weight For Height (WFH), Weight For Age (WFA) and HFA Z score respectively. These indices were used with binary nominal scale as suffering from wasting, underweight and stunting coded as 1, while not suffering from wasting, underweight and stunting were coded as 0. The malnutrition classifications were based on global standards: <−3 z score, <−2 z score, and ≥−2 z score (WHO, 2017). Children with WFH, WFA and HFA z score below −2 SD of the median of reference population were considered as malnourished in terms of wasting, underweight and stunting respectively and others are not malnourished (not wasted, not undernourished and not stunting). Geographical factors used in this study are the residential sectors (rural urban and estate) and Grama Niladari (GN) divisions. They are multi categorical nominal scaled variables.

Z score for WFH index was obtained using the formula given bellow

$$WFH\ Z\ Score = \frac{M_0 - M_e}{SD_e}$$

Where,

$$M_o = Observed\ Weight\ of\ an\ individual\ in\ a\ given\ Height$$

$$M_e = Median\ Weight\ of\ the\ reference\ population\ in\ a\ given\ Height$$

$$SD_o = Standared\ deviation\ of\ reference\ population\ in\ a\ given\ height$$

Z score for WFA index was obtained using the formula given bellow

$$WFA\ Z\ Score = \frac{M_0 - M_e}{SD_e}$$

Where,

$$M_o = Observed\ Weight\ of\ an\ individual\ in\ a\ given\ Age$$

$$M_e = Median\ Weight\ of\ the\ reference\ population\ in\ a\ given\ Age$$

$$SD_o = Standared\ deviation\ of\ reference\ population\ in\ a\ given\ Age$$

Z score for HFA index was obtained using the formula given bellow

$$HFA\ Z\ Score = \frac{M_0 - M_e}{SD_e}$$

Where,

$$M_o = Observed\ Height\ of\ an\ individual\ in\ a\ given\ Age$$

$$M_e = Median\ Height\ of\ the\ reference\ population\ in\ a\ given\ Age$$

$$SD_o = Standared\ deviation\ of\ reference\ population\ in\ a\ given\ Age$$

The study fitted binary logit model or binary logistic regression model described as follows

$$logit\ P(x) = log\left(\frac{P(x)}{1-P(x)}\right) = \propto + \sum_{i}^{n} \beta_i X_i$$

$$\propto = intercept$$

$$\beta_i = Slop\ coefficients$$

$$Binary\ dependant\ variable = Malnutrition\ (Wasting/Undeweight/\text{Stunting})$$

$$X_i = Geographoical\ independant\ variales$$

$$X_1 = Residential\ Sectors$$

$$X_2 = GN\ division$$

$$i = 1,2$$

$$n = Number\ of\ independant\ variables$$

Hypothesis:

Null: There is not a significant differential impact of residential sectors on child malnutrition in Sri Lanka

Alternative: There is a significant differential impact of residential sectors on child malnutrition in Sri Lanka

4. RESULTS AND DISCUSSION

4.1 Sample distribution

The sample distribution with respect to the residential sectors and GN divisions is given in Table 4.

Table 4: Sample distribution by residential sectors and GN divisions

Geographical Variables	Levels	Number of children	Percentage (%)
Residential Sectors	Rural	258	68
	Urban	80	21
	Estate	40	11
GN Divisions	1	73	19
	2	96	26
	3	43	11
	4,5,11,13	69	18
	6,7,8,9,10,12,14,15,16	97	26

Source: Sample survey, 2023

Table 4 shows that, considering the residential sector, the highest, 68% of the sample is represented by the rural sector while the lowest with the estate sector (11%). The urban sector representation in the sample (21%) is higher than estate sector representation (11%). Considering the GN division, more than 50% of the sample is represented by the first, second and the third GN divisions. All other GN divisions contributed 44% for the sample.

The Table 5 provides the distribution of the sample relating to gender, race, religion, type of school, poverty, income and expenditure.

Table 5: Sample distribution by key characteristic of the sample

Categorical Variables	Levels	Number of children	Percentage (%)
Gender	Male	207	55
	Female	171	45
Race	Sinhala	271	72
	Tamil	93	24
	Muslim	7	2
	Burger	7	2
Religion	Buddhist	263	70
	Hindu	81	21
	Islamic	7	2
	Catholic	27	7
Type of school	Type 1AB	141	37
	Type 1C	140	37
	Type 2	97	26
Poverty	Poor	69	18

	Non-poor	309	82
Quantitative Variable		**Minimum**	**Maximum**
Income		2500	84500
Expenditure		3000	60000

Source: Sample survey, 2023

As indicated in Table 5, the male portion of the sample (55%) surpasses the female portion (45%). In terms of ethnicity, Sinhalese make up the largest group, comprising 72% of the sample, while Muslims and Burgers are the smallest groups, each representing 2%. When it comes to religion, 70% of the sample identifies as Buddhist, while only 2% belong to the Islamic faith. Both type 1AB and type 1C schools account for 37% of the sample each, whereas type 2 schools have the lowest representation at 26%. Additionally, 18% of the children come from poor families, compared to 82% from non-poor families based on Samurdhi beneficiary. In terms of family income and expenditure, the maximum recorded monthly income is 84,500 rupees, with a maximum expenditure of 60,000 rupees. The minimum recorded monthly income is 2,500 rupees, while the lowest expenditure is 3,000 rupees

4.2 Prevalence of malnutrition

Prevalence of malnutrition in the aspect of wasting, underweight and stunting computed using the sample from the Nuwara-Eliya district are given below.

Table 6: Prevalence of Malnutrition - Wasting, Underweight and Stunting

Type of malnutrition	Malnutritional status	Number of children	Percentage (%)	Total
Wasting	Suffering from Malnutrition	104	27.5	378
	Not suffering from Malnutrition	274	72.5	
Underweight	Suffering from Malnutrition	100	26.5	378
	Not suffering from Malnutrition	278	73.5	
Stunting	Suffering from Malnutrition	87	23	378
	Not suffering from Malnutrition	291	77	

Source: Sample survey, 2023

Table 6 indicates the percentages of children suffering from malnutrition and not suffering from malnutrition in the study area in all its three aspects. It is evident that the percentage of children suffering from malnutrition in all three aspects appears

considerably high within the sample. It is higher than 20% for all types indicating more than one-fifth of the sample as victims of malnutrition. The highest incidence of child malnutrition is recorded as 27.5% in terms of Wasting while the second place has gone to Underweight (26.5%). The percentage of malnutrition is the least in terms of stunting, recording 23%. The malnourished percentages (27.5%) found in this study is higher than the malnourished percentages (11.8%) (for under five-year children) provided by the Department of Census and Statistics (2017) for wasting, which was measured through the WFH z score for the Nuwara-Eliya district. In contrast, the malnourished percentages (26.5% and 23%) found in this study are lower than the malnourished percentages (39.6% and 32.4%) (for under-five year children) provided by the Department of Census and Statistics (2017) for Underweight and Stunting, which were measured through the WFA z score and HFA z score respectively for the Nuwara-Eliya district.

In investigating the incidence of child malnutrition by residential sectors, child malnutrition in terms of wasting, underweight and stunting was measured using three indices WFH, WFA and HFA respectively.

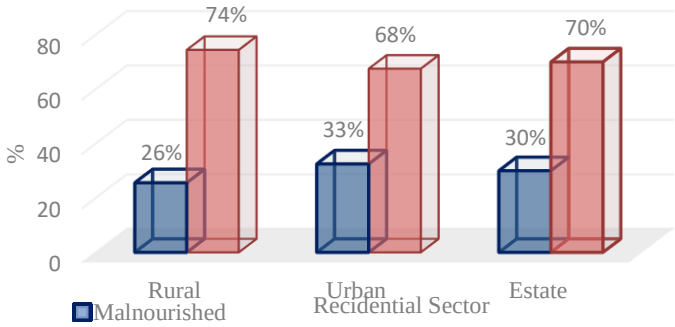

Figure 3: Child Malnutrition in the aspect of wasting by Residential Sector

Source: Sample survey, 2023

Figure 3 discloses that the malnutrition in terms of wasting has appeared to be the highest (33%) among the school children coming from the urban sector. The least percentage of malnutrition among children (26%) appeared among the children living in the rural sector. Anyhow, it does not exist a significant variation in malnutrition between among the children who come from the urban sector (33%) and estate sector (30%).

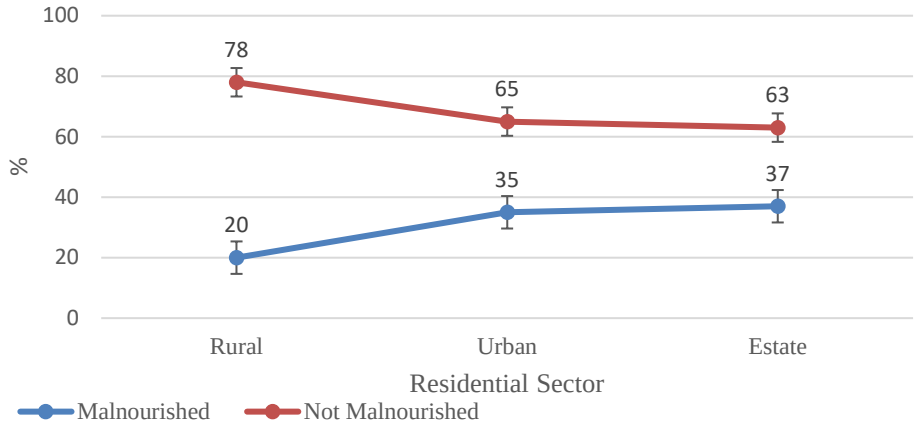

Figure 4: Child Malnutrition in the aspect of underweight by Residential Sector

Source: Sample survey, 2023

As evident from Figure 4, the proportion of children having malnutrition in terms of underweight is the highest in the estate sector (37%). The least proportion of child undernutrition (20%) is evident among the children living in the rural sector.

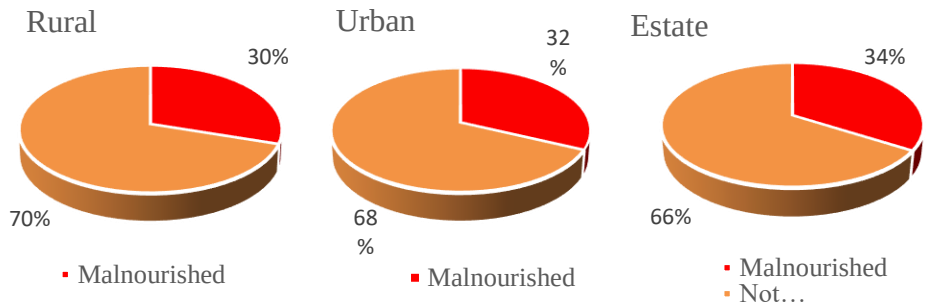

Figure 5: Child malnutrition in the aspect of stunting by residential sector

Source: Sample survey, 2023

Figure 5 shows that 34% of estate sector children are suffering from malnutrition in terms of stunting recording the highest. The least proportion of child stunting (30%) appears among the children living in the rural areas. Anyhow, there is a significant difference in malnutrition in terms of stunting among three sectors; rural, urban and estate. It is evident that in both aspects of underweight (37%) and stunting (34%), malnutrition is highest in the estate sector. In the aspect of wasting it is highest among the children living in the urban sector. The rural sector recorded lowest proportion of child malnutrition in all aspect; wasting (26%), underweight (20%) and stunting (30%).

4.3 Binary logit model

The response variable was the occurrence of malnutrition in the aspect of Wasting, Underweight and Stunting measured through WFH z score, WFA z score and HFA z score indices respectively. Initially two geographical determinants; residential sectors and GN divisions were considered as explanatory variables. The crucial assumption for fitting binary logit model is no multicollinearity among independent variables. The model used two independent variables residential sectors and GN divisions. Both tested variables are categorical, and the chi-square test was conducted to assess multicollinearity.

Table 7: Checking multicollinearity between residential sectors and GN divisions

Chi-Square Tests			
Test	**Value**	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	104.945[a]	30	.000
Likelihood Ratio	103.225	30	.000
Linear-by-Linear Association	4.282	1	.039
N of Valid Cases	378		

Source: Sample survey, 2022

Table 7 reveals the results of chi-square test for the relationship among GN division and residential sector (Geographical variables) considered for binary logistic regression analysis. It clearly shows the statistically significant relationships between these two variables at 0.01 levels. Therefore, GN division was excluded from the model because it violated the assumption of no multicollinearity. Finally, three binary logistic models were fitted for wasting, underweight and stunting separately using the variable; residential sector as the geographical independent variable excluding GN division.

Table 8: Binary logistic regression model for underweight (WFA)

Explanatory Variables		**B**	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Residential Sector				22.328	2	.000	
	Rural	-1.609	.358	20.251	1	.000	.200
	Urban	-.847	.399	4.500	1	.034	.429
Constant		.000	.316	.000	1	1.000	1.000
-2 Log likelihood			385.680				
Hosmer and Lemeshow Test			0.000 (p value=1.000)				

Source: Sample survey, 2023

Base category (Reference group): Estate sector

Table 8 presents the results of binary logit model estimated to detect the differential impact of residential sectors on child

malnutrition in terms underweight. Wald statistic provides a test of the variable's statistical significance within the model of child malnutrition in terms of underweight. If the p value (Sig.) of Wald statistic is less than 0.05 the variable of the corresponding parameter is significant. The above results verify that the parameter of the variable residential sector is statistically significant implying that residential sector has influence on child malnutrition with regard to underweight at 0.001 level.

4.3.1 Hosmer-Lemeshow Test

Table 9: Results of goodness of fit tests of the fitted model for underweight (WFA)

Type of Malnutrition	Goodness of Fit Test	Test statistics value	df	P value
Underweight	Hosmer-Lemeshow Test	0.000	1	1.000
	-2 Log likelihood	385.680		
	Omnibus test Chi-square	22.158	10	0.000

Source: Sample survey, 2023

Hypothesis:

Null: Fitted model for underweight and residential sectors is adequate (Model is significant)

Alternative: Fitted model for underweight and residential sectors is not adequate (Model is not significant)

Tables 9 discloses that Hosmer–Lemeshow test statistics and corresponding p value for the model for underweight and residential sectors. P value is greater than 0.05 and the null- hypothesis is not rejected. It justifies the selected logit model for malnutrition in terms of underweight is sufficiently fit with data in this study emphasizing the selected model with residential sectors to explain the malnutrition in terms of underweight is significant.

4.3.2 -2 Log Likelihood Ratio Statistics

Hypothesis:

Null: Residential sectors is not significant in the fitted model for underweight

Alternative: Residential sectors is significant in the fitted model for underweight

As indicates in the Table 9, Omnibus test illustrated that adding the residential sector variable to the null model has reduced the -2 Log-likelihood by 22.158 (Chi-square values) with 0.000 p-value for the fitted model of underweight rejecting the null hypothesis. It concluded that selected variable residential sectors for the fitted model is statistically significant, justifying the fitted model is adequate.

Table 10: Binary logistic regression model for wasting (WFH)

Explanatory Variables		B	S.E.	Wald	df	Sig.	Exp(B)
Residential Sector				1.598	2	.450	
	Rural	-.221	.373	.349	1	.555	.802
	Urban	.116	.420	.077	1	.781	1.123
Constant		-.847	.345	6.030	1	.014	.429

Source: Sample survey, 2022

Base category (Reference group): Estate sector

Table 10 shows the outcome of binary logit model estimated to identify the differential impact of residential sectors on child malnutrition in the aspect of wasting. Wald statistic provides a test of the variable's statistical significance within the model of child malnutrition in terms of wasting. If the p value (Sig.) of Wald statistic is less than 0.05 the variable of the corresponding parameter is significant. The above results verify that the parameter of the variable residential sector is not statistically significant implying that this variable has no direct impact on child malnutrition in terms of wasting.

Table 11: Binary logistic regression model for stunting (HFA)

Explanatory Variables		B	S.E.	Wald	df	Sig.	Exp(B)
Residential Sector				2.461	2	.292	
	Rural	-.420	.368	1.305	1	.253	.657
	Urban	-.058	.415	.019	1	.890	.944
Constant		-.731	.338	4.688	1	.030	.481

Source: Sample survey data analysis, 2022

Base category (Reference group): Estate sector

Table 11 shows the outcome of simple binary logit model estimated to identify the differential impact of residential sectors on child malnutrition in the aspect of stunting. Wald statistic provides a test of the variable's statistical significance within the model. If the p value (Sig.) of Wald statistic is less than 0.05 the variable of the corresponding parameter is significant. The above results verify that the parameter of the variable residential sector is not statistically significant implying that this variable has no influence on child malnutrition in terms of stunting.

As empirical analysis reveals, the impact of residential sectors on the different forms of child malnutrition i.e. wasting, underweight, and stunning are different. The results verify that the residential sector has a statistically significant impact on child malnutrition in terms of underweight at 0.001 level. Supporting this result, Ayana et al. (2015) proved a strong relationship between malnutrition, and the place of residence. Kandala et al. (2011) established that geographical location plays a significant role in determining the nutritional status of children under five years. Similarly, Rahman and Chowdhury (2007) found that regional

differences were closely tied to severe and moderate stunting. Similarly, Debnath and Bhattacharjee (2014) also pointed out that place of residencewas a key factor in determining child malnutrition. Endris et al. (2017) also reported that living in certain regions of a country increased the risk of malnutrition.

Statistical Package for Social Sciences (SPSS) considered the estate sector as the base category (reference group) in the logit model. As shown in Table 9, odds ratio for child malnutrition in terms of underweight, between the children from rural sector and the children from estate sector is 0.200. It indicates that odds of having malnutrition in terms of underweight is lower among the children from rural sector compared to estate sector. The probability of having malnutrition for the children from rural sector, urban sector and estate sector were calculated using log odds ratios. The model predicts the probability of being malnourished (underweight) for the children from rural sector as 0.16. Further, it shows that 16% of children from rural sector are malnourished. Odds ratio between the children from urban sector reference to the children from estate sector for child malnutrition in terms of underweight is 0.429. It indicates that odds of having malnutrition in terms of underweight is lower among the children from urban sector compared to estate sector. The probability of being malnourished (underweight) for the children from urban sector is 0.30. Further, it shows that 30% of children from urban sector are malnourished. Further, the probability of being malnourished for the children from estate sector is 0.50 and it shows that 50% of children from estate sector are malnourished. Supporting this result, in the Sri Lanka context, Jayatissa et al. (2008) found that severe stunting and wasting were more prevalent in the estate regions relative to urban regions, while Jayawardena (2015) reported the greatest incidence of low birth weight in the estate sector, with nearly one-third of babies born underweight of the children age under five years. The findings of this study have pointed out that the children from estate sector are more likely to expose to malnutrition than the children from rural and urban sectors.

5. CONCLUSION

In conclusion, the logistic model found that residentials sectors have a significant impact on child malnutrition in terms underweight. However, it is not significant in terms of wasting and stunting. Having a statistically significant relationships between residential sectors and GN divisions, GN division was excluded from the model due to violation of the assumption of no multicollinearity. The study found that children from the estate sector are more likely to be exposed to undernutrition than the urban and rural sectors. Poor socioeconomic conditions, lack of food and decline in food productivity, consumption of the wrong kind of food and food insecurity, disparities in infrastructure and other services, less educated parents and fathers' alcoholism are the most probable reasons for higher child malnutrition in the estate sector. The government should implicate policies to provide infrastructure and health care services, increase food availability, and enhance socioeconomic conditions in the estate sector. Awareness programs on nutritional education should be orientated to avoid the wrong kind of food and

emphasize the importance of appropriate food patterns. Formal education, especially among females should be encouraged. Events against alcohol addiction and other harmful behaviors and attitudes should be carried out in the estate sector. There is a wide-knowledge gap in them on the nutritional requirements and protection of food nutrition that they give their children. Educational authorities should place more emphasis on the education of girls who are future mothers since they directly contribute to breaking the malnutrition circle.

6. References

Ajieroh, V. (2009). *A quantitative analysis of determinants of child and maternal malnutrition in Nigeria* (NSSP Background Paper No. 10). Nigeria Strategy Support Program (NSSP), International Food Policy Research Institute. Sustainable solutions for ending hunger and poverty.

Available at https://media.africaportal.org/documents/NSSP_Background_Paper_10.pdf

Ali Khan, R. E., & Azid, T. (2011). Malnutrition in primary school-age children: A case of urban and slum areas of Bahawalpur, Pakistan. *International Journal of Social Economics, 38*(9), 748–766.

Ayana, A. B., Hailemariam, T.W., &, Melke, A. S. (2015). Determinants of acute malnutrition among children aged 6–59 months in Public Hospitals, Oromia region, West Ethiopia: a case–control study. *BMC Nutrition, 1(34)*, 1.

Bhattacharya, A., Pal, B., Mukherjee, S. & Roy, S.K. (2019). Assessment of nutritional status using anthropometric variables by multivariate analysis. *BMC Public Health, 19***,** 1045.

Baker, P., & Friel, S. (2016). Food systems transformations, ultra-processed food markets, and the nutrition transition in Asia. *Globalization and Health*, *12(1)*, 80.

Black, R. E., et al. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet*, *382(9890),* 427-451.

Casadei, K., & Kiel, J. (2021). Anthropometric measurement. In *StatPearls* [Internet]. Treasure Island, FL: StatPearls Publishing.

Chowdhury, T. R., Chakrabarty, S., Rakib, M., Saltmarsh, S., & Devis, K.A. (2018). Socio-economic risk factors for early childhood underweight in Bangladesh. *Global Health, 14(1),* 54.

Das, S. & Gulshan, J. (2017). Different forms of malnutrition among under five children in Bangladesh: a cross sectional study on prevalence and determinants. *BMC Nutrition, 3(1)*.

Department of Census and Statistics (DCS). (2017). *Demographic and health survey report - 2016.* Retrieved from http://www.statistics.gov.lk/page.asp?page=Health

Debnath, A. & Bhattacharjee, N. (2014). Factors Associated with Malnutrition among Tribal Children in India: A Non-Parametric Approach, *Journal of Tropical Pediatrics*, *60 (3),* 211–215.

Edirisinghe, J. (2012). Malnutrition among children in the estate sector of Sri Lanka. Sri Lanka *Journal of Child Health, 41(4),* 173-177.

Endris, N., Asefa, H., & Dube, L. (2017). Prevalence of malnutrition and associated factors among children in rural Ethiopia. *BioMed Research International, 2017*(6), Article 6587853.

Fagbamigbe, A. F., Kandala, N. B., & Uthman, A. O. (2020). Demystifying the factors associated with rural–urban gaps in severe acute malnutrition among under-five children in low- and middle-income countries: A decomposition analysis. *Scientific Reports, 10*, 11172.

Fotso, J. C. (2007). Urban–rural differentials in child malnutrition: Trends and socioeconomic correlates in sub-Saharan Africa. *Health & Place*, *13(1),* 205-223.

Frongillo, E. A., et al. (2007). Patterns and predictors of growth in rural and urban children. *Journal of Nutrition*, *137(2),* 265-272.

Habyarimana, F., Zewotir, T., & Ramroop, S. (2016). Key determinants of malnutrition of children under five years of age in Rwanda: simultaneous measurement of three anthropometric indices. *African Population Studies, 30(2),* 2328-2340.

Haddad, L., Cameron, L., & Barnett, I. (2015). The double burden of malnutrition in SE Asia and the Pacific: Priorities, policies and politics. *Health Policy and Planning, 30(9),* 1193-1206.

Jayatissa, R., Hossain, M., Fernando, D., Uduwaka, C., Jayawardana, R., & Indrajith, P. (2008). *Nutritional status and its determinants in Sri Lankan under-five children*. Department of Nutrition, Medical Research Institute. Available at https://www.mri.gov.lk/assets/Nutrition/2009-children-under-five-nutrition-and-determinants-SL-.pdf

Jayatissa, R., & Hossain, S. (2010). *Nutrition and food security assessment in Sri Lanka: Estate sector report*. Ministry of Health.

Jayawardena, R. (2014). The prevalence and trends of malnutrition among children in Sri Lanka. *Journal of Nutrition, 5(2),* 112-118.

Jayawardena, P. (2015). Socio-economic determinants and inequalities in childhood malnutrition in Sri Lanka. *Well-Being and Social Policy Journal, 8 (1),* 1-22.

Kandala, N., Madungu, T. P., Emina, J. B., Nzita, K. P. & Cappuccio, F. P. (2011). Malnutrition among children under the age of five in the Democratic Republic of Congo (DRC): does geographic location matter?. *BMC Public Health 11:* 261.

Khan, J., & Mohanty, S. K. (2018). Spatial heterogeneity and correlates of child malnutrition in districts of India. *BMC Public Health, 18,* 1027, 1-13.

Khalid N, Aslam Z, Kausar F, Irshad H, Anwer, P. (2017). Maternal Malnutrition and Its Kick on Child Growth: An Alarming Trim for Pakistan. *Journal of Food, Nutrition and Population Health, 1 (3),* 3:24.

Karunaratne, P. (2011). Urban poverty and malnutrition in Sri Lanka: A review of policies and programs. *Health Policy and Planning*, *26(3),* 222-231.

Ladu, J. L.C., Athiba, A. L. & Lukaw Y. S. (2018). Impact of Malnutrition on Children Less Than Five Years of Age in Juba Payam (District), Republic of South Sudan. *American Journal of Food and Nutrition, 6(4),* 103-107.

Magalhães, R. J. S. & Clements, A. C. A. (2011). Mapping the Risk of Anaemia in Preschool-Age Children: The Contribution of Malnutrition, Malaria, and Helminth Infections in West Africa. *PLoS Med*, *8(6),* e1000438.

Monteiro, C. A., et al. (2000). Socioeconomic status and child nutrition: The Brazilian experience. *Bulletin of the World Health Organization, 78(4),* 1339-1346.

Popkin, B. M. (2002). The nutrition transition and its health implications in lower-income countries. *Public Health Nutrition, 5(1),* 205-214.

Mullerpierce, T. (2019). The living conditions of tea estate workers in Sri Lanka: A sociocultural analysis. *Asian Journal of Social Science, 45(3),* 217-234.

Perera, T., & Gunawardena, S. (2013). Child malnutrition in Sri Lanka's estate sector: An analysis of household determinants*. Colombo Journal of Public Health*, *12(4),* 122-130.

Prüss-Üstün, A., et al. (2019). Burden of disease from inadequate water, sanitation, and hygiene in low- and middle-income settings: A retrospective analysis. *The Lancet Global Health*, *7(4),* e620-e629.

Rahman, A., & Chowdhury, S. (2007). Determinants of Chronic Malnutrition among pre-school children in Bangladesh. *Journal of Biosocial Science, 39(2),* 161-173.

Rathnayake, I. M., & Weerahewa, J. (2005). Determinants of Nutritional Status among Pre-School Children in Sri Lanka. *Tropical Agricultural Research, 17*, 148-161.

Smith, L. C., Ruel, M. T., & Ndiaye, A. (2005). Why is child malnutrition lower in urban than in rural areas? Evidence from 36 developing countries. *World Development*, *33(8),* 1285-1305.

UNICEF. (2019). *The state of the world's children 2019: Children, food and nutrition*. UNICEF.

World Health Organization (WHO). (2010*). Nutrition Landscape Information System (NLIS) country profile indicators: interpretation guide*. World Health Organization.

World Health Organization (WHO). (2020). *Malnutrition*, World Health Organization. https://www.who.int/ news-room/fact-sheets/detail//malnutrition.

World Food Programme (WFP). (2016). *Food security assessment in the estate sector of Sri Lanka.* WFP.

UNICEF/WHO/World Bank Group. (2021). *UNICEF/WHO/The World Bank Group joint child malnutrition estimates: Levels and trends in child malnutrition: Key findings of the 2021 edition*. World Health Organization. Available from https://www.who.int/publications/i/item/9789240025257

Zhang, N., Bécares, L., & Chandola, T. (2016). Patterns and Determinants of Double-Burden of Malnutrition among Rural Children: Evidence

from China. *PloS one*, *11(7)*, e0158119.