PALACKÝ UNIVERSITY OLOMOUC

UNIVERSITY OF CLERMONT AUVERGNE

UNIVERSITY OF PAVIA

MASTER THESIS

Analyzing Basic and Underlying Determinants of Child Malnutrition in Nepal

Urishna Shakya

Supervisor: Professor Maria Sassi

GLODEP 2021

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DECLARATION

I, Urishna Shakya, hereby declare that this thesis titled '**Analyzing the Basic and Underlying determinants of Child Malnutrition in Nepal**' is the outcome of my own efforts. I confirm that all the work in this thesis is mine, and the literary papers and secondary sources used during this research work have been duly cited, referenced, and acknowledged.

Urishna Shakya
Date: 31st May 2021

Acknowledgement

I would like to thank my supervisor Professor Maria Sassi for her continuous guidance and support throughout these months of research work and being a source of encouragement in the whole process. It has been an insightful process to conduct a quantitative study with the knowledge gained through all our teachers and lecturers in all the previous semesters at Palacky University, Czech Republic, University of Clermont Auvergne, France and University of Pavia, Italy, especially, Dr. Miroslav Syrovátka, Dr. Simona Safarkova, Dr. Lenka Duskova, Dr. Pascal Motel Combes and Dr. Maria Sassi for enabling us to have a strong foundation through the GLODEP program. Additional thanks to Professor Gopal Trital's classes on STATA and data management which helped me handle datasets by implementing the knowledge and solve my queries during the data processing and analysis of my thesis work. My family has also been of an utmost support in this journey by always encouraging me to do my best here as they fight through the difficult COVID circumstances back in Nepal. Finally, I also want to thank my colleagues who have added the spark to this experience and made it all worthwhile.

UNIVERZITA PALACKÉHO V OLOMOUCI
Přírodovědecká fakulta
Akademický rok: 2020/2021

Studijní program: Geography
Forma studia: Prezenční
Obor/kombinace: International Development Studies (MRSA)

Podklad pro zadání DIPLOMOVÉ práce studenta

Jméno a příjmení:	**Urishna SHAKYA**
Osobní číslo:	**R190786**
Adresa:	Thaina Tole 018.13.013, Lalitpur, 44700 Lalitpur, Nepálská federativní demokratická republika
Téma práce:	Ethnic, socio-economic, gender inequalities in child malnutrition in Nepal
Téma práce anglicky:	Ethnic, socio-economic, gender inequalities in child malnutrition in Nepal
Vedoucí práce:	prof. Maria Sassi Katedra rozvojových a environmentálních studií

Zásady pro vypracování:

This thesis aims to study the effect of some of the critical sociocultural, economic and political factors affecting child malnutrition in Nepal. Specifically, it will delve into **ethnic, socio-economic and gender inequalities in child malnutrition** based on the UNICEF Theoretical framework (UNICEF, 1990).
Nepal is one of the two South Asian countries to have the highest rate of reduction in stunting. Over the years, stunting has been declining from 1996 to 2016 in all wealth groups, however, the reduction rate was lower among the poorer groups as compared to the richer ones in Nepal (Angdembe, Dulal, Bhattarai, & Karn, 2019). Additionally, previous studies have indicated that socio-economic differences contribute to higher persistence of stunting, substantially making the children in marginalized groups more affected than others (Krishna, Mejía-Guevara, McGovern, Aguayo, Subramanian, 2018). Furthermore, existing studies also highlight that one's ethnicity, class and caste have a negative impact on their rate of prevalence of malnutrition. For example, children from Dalit castes, one of the most oppressed castes in Nepal, and largely in South Asia, are more significantly affected by malnutrition as compared to Non-Dalit children in Eastern Nepal (Pramod Singh, Nair, Grubesic, & Connell, 2009).
Due to the worsening situation of child nutrition among marginalized groups, it is imperative that social, economic and politically contextual causes and effects are considered in the analysis of child malnutrition as well as in design of the intervention. However, existing literature on child malnutrition either do not focus exclusively on issues of ethnic, socio-economic and gender inequalities in child malnutrition in Nepal or are only limited to a specific administrative region. Their conclusions are not representative of heterogenous provincial level population characteristics.
In that context, this study will add the following new elements to the literature. First, the study will exclusively incorporate variables on child's ethnic, sociocultural and gender status in the analysis of child malnutrition. Second, the study will use the latest dataset from UNICEF Multiple Indicator Cluster Survey (MICS) 2019 with country-wide sample. The dataset with larger sample size is expected to increase the robustness of the results and its usefulness for the current national level Multi-Sector Nutrition Plan (II) in Nepal. This study will perform a rigorous cross-sectional analysis of child malnutrition status in a regression framework. An exact econometric model will be determined with the review of existing empirical studies as guided by the research objective. Data cleaning, management and analysis will be conducted in STATA.

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Podpis vedoucího práce: Marco Sassi Datum:

Podpis vedoucího pracoviště: Datum:

Abstract

Nepal has a high prevalence of child malnutrition, with a current stunting rate of 37.4%. To overcome the problem, Nepal has set goals and targets at both national and international policy levels. However, Nepal faces serious policy challenges in achieving these goals due to its unstable social, economic and political environment, further aggravated by the devastating 2015 earthquake and current COVID-19 pandemic. In such a situation, it is imperative to design policy interventions that reflect prevailing socioeconomic context and vulnerable population groups. Our study utilized the most recent nationally representative MICS dataset to cover the literature gap on the post-earthquake analysis of child malnutrition. We analyzed the determinants of child malnutrition at different interdependent levels of basic and underlying factors using a series of multiple linear regressions based on the UNICEF (1990) framework. The study findings report that the main determinants of child malnutrition are the child's age, gender, place of delivery, standard of living, caste or ethnicity and province. While household living standard remains one of the strongest predictors, as confirmed by previous studies, we find that socioeconomic and contextual aspects are critical factors that are to be accounted for while designing future policy interventions.

Keywords: Stunting, UNICEF framework, Socioeconomic context, Nutrition policy

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List of Abbreviations

AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
BMI	Body Mass Index
CBS	Central Bureau of Statistics
CHD	Child Health Division
HAZ	Height for Age Z-score
MICS	Multiple Indicator Cluster Survey
MNSP	Multi-Sector Nutrition Plan
MoHP	Ministry of Health and Population
NDHS	Nepal Demographic Health Survey
SDGs	Sustainable Development Goals
UNICEF	United Nations Children's Fund
VIF	Variance Inflation Factor
WAZ	Weight for Age Z-score
WHA	World Health Assembly
WHO	World Health Organization

CHAPTER I: INTRODUCTION

1.1. Chapter Introduction

This chapter elaborates on the background (Section 1.2), the objective (Section 1.3), the significance (Section 1.4), the scope and limitations (Section 1.5), and the organization of the research study (Section 1.6).

1.2. Background

South Asia is considered to be one of the major hubs of malnourished children, along with Sub-Saharan Africa and Central Asia. In 2017, the South Asian region constituted almost 35% of the total stunted children in the world. In the region, the rate of stunting reduced from 51% to 35% from the year 2000 to 2017, but the rate is still very high on a global scale (Wali, Agho, & Renzaho, 2020). Stunting, which refers to low height-for-age, is the most alarming outcome of malnutrition with irreversible long-term consequences. Stunting in a child occurs within the first 1000 days after birth, affecting their physical, cognitive, and intellectual potential. It includes various short and long-run consequences of stunting, such as effects in their academic performance, reduction in productivity leading to a lower income, and increased vulnerability to chronic diseases in adulthood (Sassi, 2018; Wali et al., 2020).

Nepal is also one of the countries within the South Asian region with an alarming rate of malnourishment. About 3.5 million people in the country suffer from food insecurity, and 42% of children under 5 years die due to malnutrition (Asian Development Bank, 2011). With one of the highest child stunting rates in the region, Nepal faces a persistent problem of child stunting. A study published in 1984, and possibly the earliest analysis of child stunting in Nepal, reported that child stunting rates were among the highest in the country (Martorell, Leslie, & Moock, 1984). While the stunting rate in Nepal has reduced over the years, the current stunting rate (37.4%) is still critical (Joshi & Chitekwe, 2019; "Multi-sector Nutrition Plan II (2018-2022)," 2017).

To better the situation of child stunting, WHO has set up Global Nutrition Targets to reduce child stunting by 40% to be achieved by the year 2025. Additionally, Nepal has set an aim as a part of the Sustainable Development Goals (SDGs) to reduce the stunting rate among under 5 years

children to 1% by 2030 (Devkota, Adhikari, & Upreti, 2016 ("National Nutrition Policy and Strategy," 2008). In regard to the domestic policy mechanism, Nepal's current national-level program on improving child nutrition functions under Multi-Sectoral Nutrition Plan II (MSNP 2018-2022). It was initiated in December 2017 and aims to better the nutrition intake level of the Nepali population. Its primary goals are to improve the population's nutrition level by intensifying the current nutrition intake-related response programs and activities, increasing access and availability of services, and beefing up the policy-level intervention via stronger coordination at local, governmental, and provincial levels (Joshi & Chitekwe, 2019; "Multi-sector Nutrition Plan II (2018-2022)," 2017).

Nepal's progress over the years had also given Nepal praises of "the fastest recorded decline in child stunting in the world" because of more political stability in the country after the end of the People's civil war (Webb, West, & O'Hara, 2015). It had helped bring a lot of positive changes in the infrastructure situation of the country, among others. However, Nepal suffered a devastating earthquake in 2015. The earthquake hit the entire economy and also brought the progress made on the nutritional front to a halt, with disruption in thousands of families' health and nutrition intake via destruction in major health infrastructures such as hospitals, roads and markets. In the majorly hit 14 districts, half of their stored food and 20% of their raised animals were destroyed (Webb et al., 2015). In that context, it is imperative that policy frameworks devised to combat child nutritional outcome should also reflect the post-earthquake socioeconomic context of the country.

Socioeconomic and political context plays a very important role in driving the determinants of child nutrition (Ekbrand & Halleröd, 2018). Existing studies attribute child stunting to various factors such as poverty, lack of mother's education, food insecurity, lack of proper caring practices, such as breastfeeding of infants and young children, lack of proper diet and prevalence of infections and diseases due to an unhealthy environment (Dorsey et al., 2018; Pramod Singh, Nair, Grubesic, & Connell, 2009; Smith & Haddad, 2000). These factors are affected by the overarching socioeconomic and political context of the country (UNICEF, 1990). Given this linkage, it is critical that the determinants of child nutritional outcome are timely identified in a revised socioeconomic context.

Further, the prevalence of child stunting is also an indicator of deprivation and inequalities within and between different groups in the population. In Nepal, the historical social system has given

rise to severe inequalities across different marginalized groups with limited access to the country's economic, social and political resources. These marginalized groups are disproportionately affected by the extreme economic consequences of the earthquake in Nepal. It is, therefore, imperative to address child stunting determinants across these groups that are most vulnerable to socioeconomic and political changes in Nepal (Victora, Onis, Hallal, Blössner, & Shrimpton, 2010).

Unfortunately, despite having studies on child stunting determinants, none of them is based on the nationwide post-earthquake data. One of the reasons behind the lack of studies was the unavailability of quality and representative data. The data unavailability issue is now resolved after the publication of Multiple Indicator Survey (MICS) Data by UNICEF in 2020. This dataset is, by far, the most recent post-earthquake dataset representative of all seven provinces in Nepal. In this study, we utilize this latest MICS dataset from the survey year 2019 and cover the literature gap in the analysis of child stunting determinants in the current socioeconomic context of Nepal.

1.3. Objective of the Study

This study aims to analyse the basic and underlying determinants of child malnutrition in Nepal, based on the UNICEF (1990) framework.

1.4. Significance of the the Study

This study is novel in its investigation of child malnutrition from the perspective of underlying and basic causes, more importantly, with a focus on the gender, socioeconomic, and ethnic dimensions using the latest national-level survey dataset.

This study intends to cover the following literature gap in regard to child malnutrition in Nepal. First, most studies conducted in Nepal on the topic of child malnutrition refer to survey datasets pre-Nepal earthquake 2015. As previously indicated, Nepal's devastating earthquake in 2015 had far-reaching consequences in Nepal's socioeconomic and political context, which might affect underlying determinants of child stunting as highlighted in the UNICEF (1990) framework. Our study, therefore, intends to contribute to the current policy mechanism in the country to address post-earthquake child nutritional strategies.

Second, previous studies on the topic (Dorsey et al., 2018; Karkuki Osguei & Mascie-Taylor, 2019) mostly used child stunting as a binary outcome variable with the limitation that the entire range of child's height is not analyzed in the study. In our study, we assess child stunting determinants utilizing the child's HAZ as a continuous variable. This allows for a better estimate of the policy variables that are to be considered in child nutritional programs.

Third, most studies in Nepal are either limited to specific geographic areas (Pramod Singh et al., 2009; Sah Nepali, 2008) or do not have exclusive socioeconomic, ethnic, and gender focus in their analysis. Our study addresses this gap by acknowledging and analyzing the prevailing socioeconomic context in Nepal, including variables on caste and ethnicity, gender, and locational information of the households in the analysis of child stunting.

1.5. Scope and Limitations of the Study

This study analyzes child malnutrition in terms of stunting for children under 5 years of age and uses a nationwide dataset conducted in the year 2019. The study covers rural and urban areas of all the seven provinces of Nepal. This study, however, is cross-sectional, and therefore, does not intend to establish a causal relationship for all the factors of child stunting.

1.6. Organization of the Study

The following chapter, Chapter II, reviews the theoretical and empirical literature on the topic, Chapter III elaborates the methodological framework and empirical strategy employed in our study, and Chapter IV presents the results and discusses them. Chapter V highlights our key conclusion and policy recommendations (Chapter V).

CHAPTER II: LITERATURE REVIEW

2.1. Chapter Introduction

This chapter presents a review of the theoretical literature in Section 2.2 where we discuss the global issue of child malnutrition (Section 2.2.1) and its causes (Section 2.2.2). Additionally, we also narrow down on child stunting as one of the most urgent forms of malnutrition that our study focuses on and the rationale of selecting it as an outcome variable (Section 2.2.3). The chapter also discusses the policy context of Nepal in Section 2.3. Finally, the chapter presents a review of empirical literature focused on various studies conducted on the topic in Section 2.4.

2.2. Review of Theoretical Literature

2.2.1. Child Malnutrition

According to WHO, child malnutrition can be described as deficiency, excess, or imbalance in a child's nutrients intake. These lead to undernutrition of three forms: wasting, stunting, underweight, and overnutrition resulting in overweight (Ge & Chang, 2001; Sassi, 2018; WHO Working Group, 1986). In our study, we focus exclusively on child malnutrition resulting due to undernutrition. The three forms of undernutrition are described as the following.

Wasting refers to the state of children who have low weight concerning their height. It results due to acute deficiencies in various factors such as food insecurity, lack of proper access to health care, inappropriate nutrition, inadequate food intake, and lack of clean and healthy environment (Ge & Chang, 2001; Sassi, 2018; WHO Working Group, 1986).

On the other hand, **stunting** in children refers to their hampered development in terms of their low height relative to their age. Contrary to wasting, stunting indicates the long-term effects of chronic deficiencies and lack of proper nutrition. Stunting affects their overall health and makes them vulnerable to other infections and diseases. It hinders the overall development of the child including mental and intellectual growth (Ge & Chang, 2001; Sassi, 2018; WHO Working Group, 1986).

Finally, **underweight** indicates the children who have low weight concerning their age. It is also a composite indicator of both wasting and stunting (Ge & Chang, 2001; Sassi, 2018; WHO Working Group, 1986). These nutritional outcomes are measured in comparison with WHO standards. Wasting, stunting and underweight are defined as weight for height, height for age, and weight for age that are 2 standard deviations below the WHO Child Growth Standards median, respectively (Sassi, 2018; "WHO | Global Nutrition Targets 2025: Wasting policy brief," 2018).

2.2.2. Child Stunting as nutrition outcome variable

Malnutrition, in general, has been affecting many lives and causing hindrances in the socio-economic and health development of Nepal (Joshi & Chitekwe, 2019; "Multi-sector Nutrition Plan II (2018-2022)," 2017). Among the three outcomes of malnutrition, stunting is the most urgent indicator of child nutritional outcome and is even referred to as one of the deadliest causes of deaths by WHO ("WHO | Global Nutrition Targets 2025: Wasting policy brief," 2018).

Stunting incurs many short and long-run implications such as a higher probability of suffering from infections leading to child or mother's death, decrease in height as adults, and chronic diseases in adulthood and further hampering the child's life (Kim, Mejía-Guevara, Corsi, Aguayo, & Subramanian, 2017). The lack of proper growth in the child in their formative years can affect them in the long term creating ripple effects in their overall growth and development ("Stunting in a nutshell," 2015).

Stunting in children also indicates the effects of lack of nutrition during or even before the time of birth, and thus, it can be considered a strong indicator of household-health environmental status or long-lasting challenges in a child's physical, mental, and intellectual growth. Thus, it assesses socio-economic, cultural, environmental, and demographic aspects and captures long term effects pre and post-childbirth and is overall a good indicator for analyzing child malnutrition (Angdembe, Dulal, Bhattarai, & Karn, 2019). For these reasons, we focus on child stunting as an outcome variable of interest in our study.

2.2.3. Causes of Child Malnutrition

The UNICEF (1990) framework, in figure 1, explains the causes of malnutrition in three interrelated hierarchies of immediate, basic, and underlying factors. These factors range from child-specific characteristics to household-level determinants within the overarching social,

economic, and political context. The framework, thus, acknowledges that the issue of malnutrition is cross-sectoral and includes a list of multi-faceted aspects such as human, economic, and organizational resources that are affected by local, national and international structures (Black, Lutter, & B Trude, 2020). The framework is a fundamental starting point to study and assess the causes of malnutrition. It stresses the importance of understanding causal relationships at both micro and macro levels, i.e., at individual or household and societal or community levels.

Figure 1: UNICEF Conceptual Framework 1990 (Sassi, 2018; UNICEF, 1990)

The UNICEF (1990) framework levels the causes of child stunting into three tiers - immediate, underlying, and basic factors. The uppermost 'immediate cause' includes the micro-level physiological factors of malnutrition affecting at an individual level, such as diet consumed and health conditions. They are inter-dependent and are further influenced by the three underlying causes. These underlying causes are food insecurity, lack of enough maternal and childcare, a safe household environment, and access to health care facilities and services. Finally, at the bottom level of the framework lies the basic causes of malnutrition, which encompasses resources influenced by various social, economic, and political factors in their usage. These affect the issues of food security, health services, and the health environment at the household level (Sassi, 2018; Smith & Haddad, 2000).

Following is a brief description of each component of the immediate, underlying and basic causal factors of child malnutrition as indicated in the UNICEF (1990) framework.

2.2.3.1. Immediate causes of child malnutrition

i. Inadequate diet intake

Lack of adequate dietary intake falls under one of the proximate factors in the framework, which directly hampers the nutritional outcome for children (Sassi, 2018; UNICEF, 1990). However, studying the adequacy of dietary intake at individual child-level is a challenge from the perspective of data collection. Dorsey et al. (2018) studied diet intake in their research through a seven-day food frequency, and dietary diversity questionnaire reported until a week before the interview. Similarly, Pramod et al. (2009) used proxies for the dietary intake in terms of the mother's diet consumed at the time of pregnancy and their participation in the nutritional program.

In our study, however, we have refrained from using these proxies in our analysis, first, due to the incomplete data on individual-level dietary intake, and second, to avoid any endogeneity issues.

ii. Diseases/ Infections

This individual-level factor includes concerns regarding proximate health conditions that could affect the child directly with other long-term consequences on future adult height, cognitive capability, economic calibre, overweight issues and chronic diseases, among others (UNICEF, 1990). In the literature, child-level diseases or infections have been proxied by information on

child morbidity (Dorsey et al., 2018). In our study, we do not account for this causal factor due to similar concerns as in the case of inadequate dietary intake.

2.2.3.2. Underlying causes of child malnutrition

i. Household food security

Household food security is defined as a situation "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Policy Brief Changing Policy Concepts of Food Security, 2006, p.1). Food security has four dimensions – availability, accessibility, utilization, and stability, each of which could significantly affect the nutritional outcome for a child (Sassi, 2018). In our study, we have not included household food security variables due to data availability issues and to minimize any possible endogeneity bias.

ii. Inadequate maternal and child-care, feeding practices

Literature suggests that an inadequate level of maternal and child-care leads to the poor nutritional outcome for child (Sassi, 2018). These factors are proxied by various indicators in the literature. For example, McGuire (2006) explains that the usage of maternal and child-care practices could be proxied by household-level choice for place of child delivery, access to medical attendance during child birth by a skilled medical professional attendance and, timely and complete child vaccination. More importantly, prenatal and antenatal care utilisation is also considered indicators of maternal and child care. 'Prenatal care' is defined as the rate of women of 15-49 years who sought and met a skilled health professional at least once during their pregnancy. However, the information on this variable was not complete in the MICS dataset.

Therefore, in our study, we have used the variable' place of child delivery' to assess the adequacy of maternal and child-care in the analysis.

iii. Unhealthy household environment and inadequate health services

An unhealthy household environment and inadequate health services could lead to diseases and infections, limiting a child's capacity to absorb nutrients. Consequently, households exposed to deteriorated sanitation conditions compromise the nutritional outcome for their members (Sassi, 2018). These factors are usually assessed by proxy variables related to household-level sanitation conditions, including accessibility and availability of improved sources of drinking water, type of

toilets used by the members, availability of improved cooking stoves, among others (Kamal, 2011). In our study, we have used 'incidence of diarrhoea in the last seven days before the survey' as a proxy for the outcome of an unhealthy household-level environment, as also suggested in the literature (Babu, Gajanan, & Hallam, 2017).

2.2.3.3. Basic causes of child malnutrition

i. **Household access to adequate resources**

Accessibility to resources such as land, education, employment, income and technology affects household members' ability to enable their living environment towards food security and child-care practices (Sassi, 2018; UNICEF, 1990). Most studies use parent's, mother's, and/or father's education to proxy household access to resources that could improve their child's nutritional outcome (Kim et al., 2017; Vollmer, Bommer, Krishna, Harttgen, & Subramanian, 2017). Following that, we have used the mother's education as a proxy to assess household-level ability to access and utilize their resources in our study.

ii. **Lack of financial, human, physical, and social capital**

Household-level financial, human, physical and social capital influences the access, availability and utilization of underlying factors that could contribute to child nutritional outcome (Sassi, 2018; UNICEF, 1990). In the literature, household-level capital is usually proxied by relative household wealth. For example, Angdembe et al. (2019), in their study of child nutrition in Nepal, use a wealth index to proxy household-level capital. Some other studies (Charlotte J. W. van Tuijl, D'onya S. Madjdian, Hilde Bras, & Binaya Chalise, 2020) also use monthly household income to proxy for resources available to the household.

In our study, the MICS dataset does not have information on household income. Therefore, we have used the wealth index computed by MICS to proxy for the household-level capital. The computation of wealth index uses variables regarding information about specific assets in the household and reflects their relative living standard. The wealth index is also referred to as an asset index as it includes information on the household's possession of quantity and type of TV, bicycle, car or motorcycle, type of drinking water sources, toilet facilities, type of house and flooring materials (Rutstein, 2008).

iii. **Sociocultural, economic, and political context**

The sociocultural, economic, and political determinants influence the household integrally in the major life functions and affect their ability to exercise basic human rights leading to undernutrition. Stunting being an indicator of chronic undernutrition, is impacted by the level of socioeconomic status (Sassi, 2018). To assess the effect of these factors, Charlotte et al. (2020) used development region, ecological zone, caste, or ethnicity in their analysis. In another study, Kamal (2011) included the residence of administrative regions, religion, and gender of household-head to proxy for socio-economic and cultural variables.

In our study, we have used gender and caste or ethnicity of household-head and household location in terms of rural or urban areas and province to control for the overarching sociocultural, economic, and political context.

2.3. Review of Policy Context in Nepal

2.3.1. Review of Nepal's social context

Nepal features a distinctive case of caste and ethnicity-based group differentiated social system. Central Bureau of Statistics (CBS) Nepal (2012) reports 127 caste and ethnic groups in Nepal. In 1854, these ethnic groups were legally defined in terms of the hierarchial Hindu caste system by the then Civil Code of Nepal. The hierarchy involved the discrimination between and within groups in social, economic and political access of individual members based on their ascribed status of ethnicity and caste (Williams et al., 2020). While Nepal's caste system has largely subsided over the years, the discrimination of individuals based on their ethinic and caste-based membership is still reminiscent in Nepalese society (Bennett, 2008; Williams et al., 2020).

It is imperative to note that Nepal's current ethnic and caste-based groups are not hierarchical according to Nepal's Constitution 2015, which recognizes that all citizens as equal. However, the inherent ethnic and caste driven social marginalization of these groups in the consumption and production of social, economic, and political resources necessitate that any population-based studies consider this reality. In that context, our study also analyses child nutritional outcome accounting for the socioeconomic differentiation that exists in the country.

Following are the four distinctive ethnicity and caste-based groups that are generally recognized in population studies in Nepal.

i. Brahmin and Chettri

This Hindu-religion-based caste group is usually recognized as a high caste group and is most resourceful of the country's social, economic, and political opportunities (Bista, 1991; Dahal & Head, 2014; Williams et al., 2020).

ii. Newar

This ethnic group is considered lower in the hierarchy than 'Brahmin and Chettri' but, nonetheless, have access to economic opportunities given its concentration in and around the Kathmandu valley (Bista, 1991; Dahal & Head, 2014; Williams et al., 2020).

iii. Hill Janajati

This is a conglomeration of various caste and ethnicity-based groups that are considered lower in the hierarchy than 'Brahmin and Chettri' and have lower access to economic and political resources of the country than the 'Newars'. Members of this group are usually assumed to be historically concentrated in the hilly areas of Nepal outside of the Kathmandu valley, with lower economic opportunities and higher levels of social differentiation (Bista, 1991; Dahal & Head, 2014; Williams et al., 2020).

iv. Terai Janajati

This group also refers to several other ethnicity-based groups historically located in the lower plains of Nepal and are socially, economically and politically marginalized (Bista, 1991; Dahal & Head, 2014; Williams et al., 2020).

v. Dalit

The term 'Dalit' is used in reference to the caste-based groups situated in the lowest rank in the hierarchial system introduced by the 1854 Civil Code. Historically, members of these groups were already excluded from any form of socioeconomic and political access in the country (Bista, 1991; Dahal & Head, 2014; Williams et al., 2020).

However, Nepal's social differentiation is further complicated by several other factors, including the geographical origin, migration trends and patterns, and the extent of socioeconomic access gained by the members through the process of social integration over the years. Among the 127 caste and ethnic groups in Nepal, 63 are pure ethnicity-based groups, 20 are Dalit groups, 39 are

non-Dalit caste-groups, and 5 are termed 'muslims and others' (Bista, 1991; Dahal & Head, 2014; Satyal, Corbera, Dawson, Dhungana, & Maskey, 2020; Williams et al., 2020).

In our study, we distinguish between the following four groups based on their socioeconomic access in Nepal's current context. These groups are 'Brahmin and Chhetri', 'Dalit', 'Janajati', and 'Muslim, Terai caste and others'.

Definitions of 'Brahmin and Chhetri' and 'Dalit' groups are already discussed above. The group 'Janajati' comprises both 'Hill Janajati' and 'Terai Janajati', as defined above. Most importantly, the group 'Muslim, Terai caste and others' include several other marginalized caste and ethnic groups historically located in the Terai region of Nepal. These groups not only have lower social and economic access in relation to higher caste groups but are also subject to a higher degree of marginalization within other Terai-based ethnic groups and are, therefore, most vulnerable.

2.3.2. Review of Nepal's Policy Structure and Child Nutrition Programs

There have been various initiatives at the policy level to improve the malnutrition situation in Nepal. From the year 1978, there have been several comprehensive programs, action plans, strategies under the Ministry of Health and Population (MoHP) with an overall aim to improve the nutrition situation in the country. The main activities include breastfeeding awareness programs, information dissemination campaigns on complementary foods, child care monitoring, provision of antenatal care services, de-worming interventions at the time of pregnancy, sensitization programs regarding child feeding practices, behavioural change related to children's diet and nutrition restoration programs including workshops, training and seminars via medical experts (Banstola Amrit, 2012b; "Multi-sector Nutrition Plan II (2018-2022)," 2017).

Along the same line, MoHP's nutrition section organizes a 'nutrition promotion week' around the country to strengthen the nutrition building programs. These programs include specific services like nutritional supplementation, enrichment, nutrition education and rehabilitation as the focus area of the project. The government programs on improving nationwide nutrition are conducted through various institutions. Ministry of Local Development (MoLD) coordinates children upliftment activities with other ministries, such as conducting health awareness programs in its health posts all over the country under MoHP. Further, under the direction of MoHP, Directorates

of health services and District Public Health Office/ District Health Office (DPHO/DHO) conduct counselling and women activation programs, training and community service, and mobilization of volunteers in line with national-level health and nutrition programs (Banstola Amrit, 2012b; "Multi-sector Nutrition Plan II (2018-2022)," 2017).

Moreover, the Municipalities and Village Development Committees (VDCs) carry out Early Childhood Development (ECD) programs at a local level through which they assess the dietary intake situation of children under 3 years (Banstola Amrit, 2012b).

Some of the recent policy programs in Nepal include the 'National Nutrition Policy and Strategy, 2004 (CHD 2004)' which oversaw the main nutrition implementation initiatives in Nepal in partnership with the non-governmental bodies like that of United Nations Mission in Nepal (UNMIN), World Food Program (WFP), Save the Children Alliance, United States Agency for International Development (USAID), and UNICEF-Nepal (Banstola Amrit, 2012a).

Following CHD 2004, Nepal implemented the Multi-Sector Nutritional Program (2013-17), which focused on implementing nutrition-specific and nutrition-sensitive programs to combat malnutrition in the country. The program recognized that health, education, water and sanitation, agriculture and livestock, local governance, and women, children, and social welfare sectors played a leading role in improving nutrition in Nepal. After the completion of the program, Nepal further revised the current Multi-Sectoral Nutritional Program MSNP-II for the year 2018-2022. The current program seeks to continue the previous work by increasing the number of services providing institutions, improving the accessibility and utilization of nutrition-specific programs (Banstola Amrit, 2012b; "Multi-sector Nutrition Plan II (2018-2022)," 2017).

At the international level, Nepal also had set goals for World Health Assembly (WHA)'s global nutrition target of reducing child stunting rates by 40% by 2025. However, Nepal's current stunting rate (37.4%) is far above the rate (24.3 %) that was to be achieved by the current year for the country to reach the WHA goals ("Multi-sector Nutrition Plan II (2018-2022)," 2017).

We expect that the findings of this study would be helpful in devising the right focus areas for the country's progress towards WHA goals. Our results would contribute to the knowledge base of the interventions of the country-level program by providing updated status on the risk factors of child malnutrition in Nepal.

2.4. Empirical Literature Review

The review of empirical literature focuses on exploring the existing methodological perspectives in the analysis of child stunting and their findings thereof.

We begin our review by focusing on cross-country studies covering low-income and developing countries, and gradually narrowing them down to regional and country-specific literature, including those in the South Asian region, and finally exploring the studies made in the Nepali context.

2.4.1 Review of cross-country studies

Most studies focused on low- and middle-income countries (for example, Smith and Haddad, 2000, Li et al., 2020) highlight household socio-economic status and the parents' nutrition intake as the significant predictors of child stunting. These studies also point out that poverty, mother's education, nutrition behaviour of the household and country-specific contextual factors as critical drivers of child nutritional outcome.

2.4.2 Review of Region-specific studies

The determinants are largely similar even in studies that are focused only on specific region or countries. For example, studies conducted in Tanzania in the East-African region (Chirande et al., 2015) stress that mothers' level of education, child's gender, mother's perception of child's size, and sources of drinking water were the important predictors of childhood stunting. Similarly, in the East Asian region of Myanmar, which has a high stunting rate in the region, the major determinants of child nutrition were found to be socioeconomic status and geographical area of the household. In another study, rural children were found to be at a higher risk than urban children, and child's delivery at home, birth size, age, gender and mother-specific factors including the age of the pregnancy, level of education and height were found to have a significant effect on child nutritional outcome in the region (Kang & Kim, 2019).

In the South Asian region, Kim et al. (2017) and Wali et al. (2020) concluded that mother's height, household wealth, mother's education, age at marriage, child's age and gender, and vaccination for children were the strongest predictors of child malnutrition.

2.4.3 Review of country-specific studies in South-Asian region

Here are the findings from some of the country-specific studies in the South Asian region.

Khan, Zaheer, & Safdar (2019) report that residence in urban or rural areas, age at marriage and antenatal care were the major determinants in Pakistan. In Bangladesh, Kamal (2011) found that region of residence, father's education, toilet facilities, child's age, birth order of children and wealth index were the critical factors of children's nutritional status. Another study by Rabbani, Khan, Yusuf, & Adams (2016) point out that wealth and mothers' schooling and height are highly significant in reducing socio-economic inequalities in child undernutrition in Bangladesh. Further, in Bhutan, child characteristics such as age, gender, region, wealth quintiles, antenatal care, feeding practices were found to be significant indicators of stunting in a study conducted by (Aguayo, Badgaiyan, & Paintal, 2015). In Sri Lanka, Rannan-Eliya et al. (2013) assert that maternal height, household wealth, length of breastfeeding and altitude predicted stunting. In India, Fenske et al. (2013) reported child age and sex, household wealth, maternal education, and BMI to be the major indicators of stunting.

2.4.4. Review of Nepal-specific studies

Following are a few of the recent studies conducted on Nepal's status of child stunting.

Mother's BMI, child's age and living standard were identified as important predictors of child-nutritional outcome in a study conducted in 2009 by Pramod et al. (2009). Following that, in 2016, NDHS reported that the major predictors of child stunting were household wealth, rurality of household, mother's education, child's age, ecological zone, and province-specific contextual factors ("Multi-sector Nutrition Plan II (2018-2022)," 2017). Dorsey et al. (2018), in their study, reported factors such as maternal height and education as the major determinants of child stunting. A latter study identified additional predictors such as caste or ethnicity, living standard, and ecological zone as strong determinants of child undernutrition (Karkuki Osguei & Mascie-Taylor, 2019).

In the study conducted by Angdembe et al. (2019) that sought to identify drivers of change in child nutritional outcome in Nepal from the year 1996-2016, the authors identified wealth, caste/ethnicity, mother's education and the birth order as the most critical determining factors contributing to socioeconomic inequalities in child stunting. The same study also pointed out that

the determinants of child stunting needed to be relevant to the prevailing context in 2016 and identified household wealth, Mother's BMI, and birth order as the significant factors.

More recently, the study conducted by (Budhathoki, Bhandari, Gurung, Gurung, & Kc, 2020) found the economic status of families, ecological region of residence and mother's education to be the most significant determinants of child nutrition. Similarly, (Conway et al., 2020) also identified parent's education, mother's nutrition status, sanitation environment, mother's and child's care and economic status as the strong predictors of child stunting. Furthermore, parent's occupation and education status, income, region of residence, caste or ethnicity and awareness of child's nutritional diet and gender were also identified as significant indicators in the study by (Charlotte J. W. van Tuijl, D´onya S. Madjdian, Hilde Bras, & Binaya Chalise, 2020).

Table 1 briefly highlights recent empirical studies conducted particularly in a low-income setting, including Nepal. The table serves to identify variables that need to be included in the analysis of child stunting in Nepal and establish the relevance of the methodology employed in our study.

Table 1: List of Studies conducted on Child Malnutrition

Major determinants of child stunting:	**Region/ Country**	**Nutritional Outcome**	**Methodology**	**Study**
National income per capita, Dietary Energy Supplies, government health expenditures, Access to safe water, and Female literacy rates	Developing countries.	HAZ / WAZ	Cross-country Multiple Linear Regression	(Smith and Haddad, 2000)
Household socioeconomic status and parent's nutrition. Lesser associated factors: Household environment, health-related behaviour,	Low and middle-income countries	HAZ	Logistic regression	(Li et al., 2020)

diseases, mother's reproductive care,				
Mothers with no education, perception of child size at birth by their mothers, male children, and lack of safe sources of drinking water	Tanzania	Probability of stunting	Simple and multiple logistic regression at individual, household, and community level	(Chirande et al., 2015)
Wealth quintiles, child's gender, mother's involvement in non-agricultural occupation.	Myanmar	HAZ	Multivariable logistic regression	Kang & Kim, 2019)
Maternal height, household wealth, Mother's BMI, minimum dietary diversity, mother's education, age at marriage, vaccination for children of 6-23months.	Afghanistan, Bangladesh, India, Nepal, and Pakistan	Probability of stunting	Logistic regression	(Kim et al., 2017)
Mothers with no schooling, mother's short height, child's age, and gender	South Asian countries like Nepal, India, Pakistan, Bangladesh, Maldives	Probability of stunting	Logistic regression	(Wali et al., 2020)
Residence in urban or rural areas, age at marriage, antenatal care,	Pakistan	Probability of stunting	Univariate and multivariate binary logistic regression	(Khan et al., 2019)

Region, father's education, sanitation facilities, child's age, birth order and household wealth	Bangladesh	Probability of stunting	Multinomial logistic regression	(Kamal, 2011)
Wealth, mothers' schooling, and height	Bangladesh	HAZ	Concentration curve and index	(Rabbani et al., 2016)
Child's age, gender, region, wealth quintiles, antenatal care, feeding practices	Bhutan	HAZ	Multivariate regression	(Aguayo et al., 2015)
Mother's height, household wealth, breast-feeding practice, and altitude	Sri Lanka	HAZ	Multivariate regression	(Rannan-Eliya et al., 2013)
Child age and sex, household wealth, maternal education, and BMI	India	HAZ	Logistic regression analysis	(Fenske et al., 2013)
Age, Place of residence, household income, breastfeeding practices, specific food nutrition	Nepal	HAZ	Multiple regression analysis	(Martorell et al., 1984)
Mother's BMI, child's age, living standard	Nepal	HAZ	Logistic regression	(Pramod Singh et al., 2009)
Maternal height and education	Nepal	HAZ	Mixed effects logistic regression	(Dorsey et al., 2018)
Ecological environment, mother's education, ethnicity, living standard	Nepal	HAZ	Logistic regression	(Karkuki Osguei &

				Mascie-Taylor, 2019)
Wealth, caste/ethnicity, mother's education, birth order in 1996. Household wealth, Mother's BMI, and birth order in 2016.	Nepal	HAZ	Probit regression	(Angdembe et al., 2019a)
Parent's education, mother's nutrition status, sanitation environment, mother's and child's care and economic status	Nepal	HAZ	Mixed-method approach and Decomposition analysis	(Conway et al., 2020)
Economic status of families, ecological region of residence, mother's education	Nepal	Probability of stunting	Logistic regression	(Budhathoki et al., 2020)
Parent's occupation and education status, income, region of residence, caste or ethnicity and awareness of child's nutritional diet, gender	Nepal	HAZ	Multivariate logistic regression	(Charlotte J. W. van Tuijl, D´onya S. Madjdian, Hilde Bras, & Binaya Chalise, 2020)

CHAPTER III: METHODOLOGY

3.1 Chapter Introduction

This chapter elaborates on the conceptual framework used in the study (Section 3.2), the analytical framework adopted (Section 3.3), the data thus analyzed, and the econometric strategy employed in the investigation of the child stunting determinants in Section 3.4.

3.2 Conceptual Framework

The theoretical framework for this study is based on the conceptual framework of nutrition constructed by UNICEF in 1990, as presented in Section 2.2.2. As previously explained, the framework is an efficient tool in analyzing child malnutrition and explains its causes in three interrelated levels, namely immediate, basic, and underlying factors.

3.3 Analytical Framework

Figure 2 explains the analytical framework adopted in this study, as derived from the UNICEF (1990) conceptual framework. We have modified the framework to fit the objective of this study as the following.

First, we consider child stunting as the main nutritional outcome in our analysis conducted for the sample of children under 5 years old. Second, the immediate causes of the original framework regarding inadequate dietary intake and diseases/ infections are not included in the analytical framework due to the nature of our dataset and possible issues of endogeneity. Third, regarding the underlying causes, 'inadequate maternal and childcare and feeding practices' and 'household health environment' are proxied by variables 'place of child delivery' and 'self-reported incidence of diarrhoea among children', respectively.

Fourth, in the basic level of causes, we have analyzed the access to adequate resources and capital in terms of the mother's education and wealth score. Previous studies have also shown that a mother's education is a significant factor that determines household level resource allocation towards producing child nutritional level outcome. (Frost, Forste, & Haas, 2005) mentioned the usage of a mother's education as a proxy marker for socioeconomic conditions. Additionally, (Gyimah, 2003) also used the mother's education as a proxy for household resources. Moreover,

the variable on wealth score proxies the underlying physical and financial capital of the household. In literature, wealth score is also considered to indicate household living standard (Rutstein, 2008). Lastly, the 'sociocultural, economic, and political context' is analyzed through the aspects of the gender and caste or ethnicity of the household head, location of residence in rural or urban areas and the province. The rural or urban status and the province also accounts for other unobserved contextual factors that could explain child stunting,

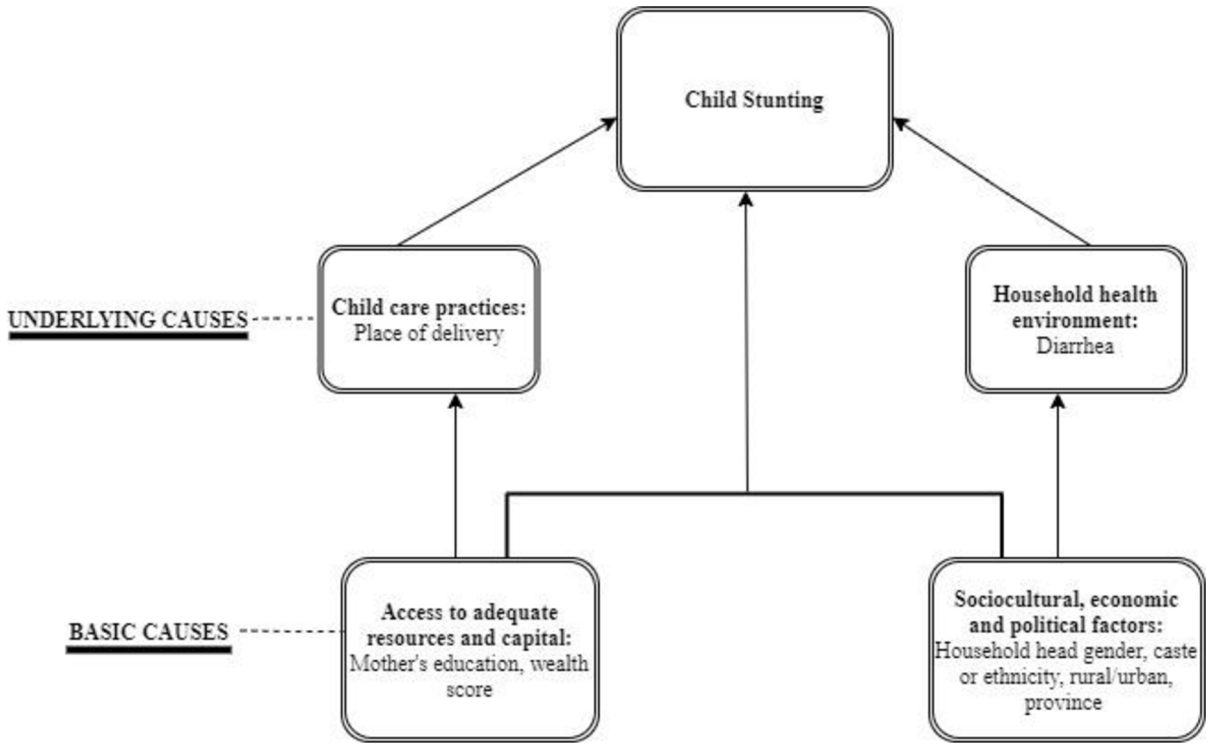

Figure 2: Analytical Framework, adapted from UNICEF (1990) framework

3.4 Empirical Strategy

3.4.1 Data and Material

In our study, we have utilized the cross-sectional dataset as used in UNICEF's Multiple Indicator Cluster Survey (MICS) carried out between March and November 2019. The MICS implemented the sampling frame as adopted in the National Population and Housing Census (NPHC). One of

the reasons behind choosing this dataset is its large-scale nationwide coverage and specific focus on children and women at rural-urban, national, and provincial level.

Our dataset consisted of 6224 children, after cleaning any incomplete observations and eliminating observations within the unexplainable range of data for the child's HAZ (with values above and below 4 standard deviations). The data came from interviews held at 12,655 households sampled from 512 enumeration areas, representative of both rural and urban areas across the seven provinces of Nepal. The sampled households were selected in two stages, in which households with and without under-5year children were selected via random sampling method in each sample enumeration area.

3.4.2 Econometric Strategy

We have analyzed the relationship between child malnutrition and its predictors using a series of OLS-based multiple linear regression models. Our strategy involves the sequential introduction of determinants in the regression equations corresponding to the three tiers of child malnutrition predictors following the analytical framework presented above and as highlighted in the UNICEF (1990) conceptual framework.

3.4.2.1 Dependent Variable

We have assessed child malnutrition in terms of child stunting based on the literature review. Child stunting captures the outcome of chronic malnutrition, which makes it an apt measure to observe the long-term deprivation in household-level causal factors. Our independent variable measures child stunting in terms of Height for Age Z-score (HAZ). The HAZ for each child is the standardized deviation of the child's height from the WHO reference median height and is already computed and made available in the MICS dataset.

It is also imperative to note that the dependent variable, HAZ score, could also be analyzed as a categorical variable by categorizing children as stunted and non-stunted based on their HAZ score. However, we have used HAZ score as a continuous variable in our analysis as doing so, the statistical information is not lost as in the case of binary classification. The simple categorization of children into stunted and non-stunted groups also does not differentiate the within-group intensity of child stunting.

3.4.2.2 Independent Variables

We have chosen the independent variables based on the basic and underlying factors causing malnutrition as per the UNICEF conceptual framework, 1990. However, we have not included the immediate factors in our models to avoid the reverse causality between stunting and the factors such as diseases or infections. Further, we could not find any appropriate instrumental variable to solve for such possible endogeneity issues. Previous studies based on the cross-sectional dataset have also highlighted the issue, as discussed in Section 2.2.3.1.

3.4.2.3 Econometric Model

We have used a series of multiple linear regression models to analyze the determinants of child stunting that were sequentially added in reference to our analytical framework. First, we begin by estimating the null model (Model 0) where HAZ refers to child *(i)*'s HAZ and ε_i refers to the unexplained residual term.

$$HAZ_i = \alpha + \varepsilon_i \qquad (0)$$

Child's HAZ score is highly affected by the child's age, and to control that, we specified the following model adding the child's age in the null model, as indicated in Model 1. In the model, β_1 is the magnitude of the relationship between a child's age and HAZ.

$$HAZ_i = \alpha + \beta_1 Age_i + \varepsilon_i \qquad (1)$$

However, the relationship between a child's age and HAZ score might be non-linear, as also described in the literature (Sassi, 2018). Therefore, to accommodate that, we estimated the following model (Model 2), where $Age\_squared_i$ refers to the square of child's age. The non-linear relationship between child's age and HAZ is confirmed if the coefficient of the age-squared term (β_2) is statistically significant.

$$HAZ_i = \alpha + \beta_1 Age_i + \beta_2 Age\_squared_i + \varepsilon_i \qquad (2)$$

Thereafter, we accounted for the gender differences in children to analyze if there exists gender discrimination in child malnutrition by adding child's gender $Gender_i$ in Model 3. In the model, β_3 is the expected difference in HAZ between the male and female child.

$$HAZ_i = \alpha + \beta_1 Age_i + \beta_2 Age\_squared_i + \beta_3 Gender_i + \varepsilon_i \qquad (3)$$

Following that, we added the underlying causes of child stunting in the model as hereunder,

$$HAZ_i = \alpha + \beta_1 Age_i + \beta_2 Age\_squared_i + \beta_3 Gender_i + \beta_U Underlying_i + \varepsilon_i \quad (4)$$

where $Underlying_i$ refers to the variables on household health environment and adequacy of health services. We have used diarrhoea and place of child delivery as a proxy for these factors, respectively. In the model, β_U stands for the vector of coefficients for the underlying variables.

Finally, we added basic causal factors of child stunting in Models 5 and 6 as the following,

$$HAZ_i = \alpha + \beta_1 Age_i + \beta_2 Age\_squared_i + \beta_3 Gender_i + \beta_U Underlying_i + \beta_4 Mother\_education_i + \beta_5 Wealth\_index_i + \varepsilon_i \quad (5)$$

$$HAZ_i = \alpha + \beta_1 Age_i + \beta_2 Age\_squared_i + \beta_3 Gender_i + \beta_U Underlying_i + \beta_4 Mother\_education_i + \beta_5 Wealth\_index_i + \beta_6 Contexual\_factors_i + \varepsilon_i \quad (6)$$

where, β_4, β_5 and β_6 are coefficients of basic factors included in our analysis. In our analysis, we include the following variables as basic causal factors of child stunting: i) mother's education, ii) household living standard and iii) social, cultural, political and other contextual factors.

For mother's education, we have re-grouped the available data on the MICS dataset into three categories "no education", "basic education", and "Secondary or higher". The regrouping of education categories was conducted to account for the distribution of sampled mother across meaningful and comparable categories. In our categorization, 'basic education' refers to all mothers who had some levels of education at the school level but never progressed to higher levels. The category 'Secondary or higher' includes all mothers who had completed post-school studies.

In reference to the household living standard, we have used the wealth index readily available in the MICS Dataset. The wealth index is expressed in terms of z-score and measures the relative wealth of the household, combining various proxies of the household living standard, including ownership of assets and building materials of the house, among others.

Finally, we have accounted for the social, cultural and other contextual factors as the following. First, we have accounted for the socioeconomic structure of Nepalese society by accounting for the gender and caste or ethnicity of the household head. Second, we have proxied the contextual factors affecting the households in terms of the location of their residence in an urban or rural area and the province.

Model (6) covers the entirety of basic and underlying factors contributing to child stunting in our analysis, and therefore, is our final model in the analysis. We have estimated each of the models specified above, using the survey sampling weight provided in the MICS dataset.

3.4.2.4 Description of Test Statistics and Model-fit Criteria

We have assessed the fit of our regression models, as specified in Section 3.4.2.3, using various fit statistics criteria as suggested in the literature. We briefly describe the test statistics and model-fit criteria that we have used in our study as hereunder.

i. t-test

We have used the student t-test, as described in (Agresti & Finlay, 1979), to ascertain whether HAZ is statistically different across two groups, for example, between male and female child, and between male-headed and female-headed households, among others. We have fixed the statistical significance level at 5 % for all the analysis that we have conducted in this study.

ii. Bonferroni correction test

Bonferroni correction test is used to identify if a continuous variable is, on average, different across multiple levels of a categorical variable, as also detailed in (Agresti & Finlay, 1979; Shaffer, 1995). In our study, we have used the Bonferroni correction test to determine whether HAZ is, on average, different across, for example, the four caste and ethnic groups, and seven provinces, among others.

iii. F-Statistics

We have used F-statistics in the following two ways. First, we referred to the F-statistics to determine the overall statistical significance of the estimated model. Second, we used F-statistics in the Wald Test to establish whether each of the determinants introduced sequentially in the regression models is statistically significant.

iv. Test for Model Specification

We have tested for the model specification bias in our study using the following two statistical tests. First, we have used Ramsey's Regression Specification Error Test (Ramsey, 1969) to ascertain whether the functional form of our model is correctly specified. We have run the test

according to the procedure described in (Baum, 2006). Second, we have tested for the omitted variable bias in our model by performing a link test as detailed in (Deb, Norton, & Manning, 2017).

v. AIC and BIC

We have also used two other model selection criteria; namely, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), to compare the competitive models, as described in (Baum, 2006; Deb, Norton, & Manning, 2017).

vi. Other measures

We have also assessed the statistical fit of our models in terms of R-squared, which is the proportion of variation of outcome variable explained by the model. Since R-squared is sensitive to the number of independent variables in the model, we have also assessed our models in terms of adjusted R-squared, as suggested in the literature (Baum, 2006; Agresti & Finlay, 1979). Moreover, we have also utilized the root mean square error value of each model in assessing the statistical model fit.

3.5 Limitations of the Study

Following are the key limitation of this study:

First, this study does not include the analysis of immediate causes of child stunting due to the following two reasons. Firstly, the immediate causes of child stunting as reflected in child's diet and disease and illness might simultaneously be the cause and effect of child malnutrition as also indicated in (Calder & Jackson, 2000; França et al., 2009). Secondly, the cross-sectional nature of the dataset and, more precisely, the lack of relevant instrumental variable does not allow the incorporation of immediate determinants of child stunting in the model.

Second, the dataset utilized in this study comes from a non-randomized cross-sectional setting, and as such, does not provide for the identification of cause-effect relationship due to the selection bias originating in the unobservability of all the factors as warranted by the UNICEF (1990) framework.

However, despite these limitations, our study incorporates a robust theoretical framework in the identification and analysis of key determinants of child stunting. The sequential regressions implemented in our study rest on the assumption of "selection on observables", thereby acknowledging the possible existence of other factors that could affect child's height for age z-scores. However, we have selected our variables based on the strong theoretical framework in the literature. More importantly, this study is not a causal study and only seeks to explain and determine the important predictors of child malnutrition, and therefore, remains valid despite its limitations.

CHAPTER IV: RESULTS AND DISCUSSION

4.1. Chapter Introduction

This chapter highlights the descriptive statistics (in Section 4.2), summarizes the results of model-fit statistics (in Section 4.3) and presents our main results and discusses them in Section 4.4.

4.2 Descriptive Statistics

Table 2 presents the descriptive statistics of the continuous variables used in our analysis. In our sample, children are, on average, 1.12 standard deviation below the WHO reference median height.

Table 2: Descriptive Statistics for Continuous Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
HAZ	-1.12	1.25	-4	2.98
Child's age	30.58	17.31	0	59
Wealth Index (z-score)	.08	.97	-1.97	2.61

Table 3 presents the descriptive statistics on the categorical variables incorporated in our models. As can be observed in the table, most children in our sample are male, had diarrhoea in the survey month and were delivered at a government facility. Regarding the household characteristics, Table 3 highlights that, on average, most households are headed by male members and are located in the urban area. On average, a higher percentage of mothers are reported to have basic, secondary, and higher levels of education. The analyzed sample consists of children from households distributed across comparable groups of caste or ethnicity.

Table 3: Descriptive Statistics for Categorical Variable

Variable	Categories	Proportion
Child's Gender	Male	**52.95%**
	Female	**47.05%**

Child had diarrhoea	Yes	**53.04%**
	No	**46.96%**
Place of delivery for child	Home	**24.17%**
	Government hospital	**63.16%**
	Private and others	**12.67%**
Mother's education	None	**25.04%**
	Basic education	**32.16%**
	Secondary and others	**42.8%**
Gender of Household head	Male	**75.3%**
	Female	**24.7%**
Caste of household head	Brahmin	**27.78%**
	Dalit	**16.12%**
	Janajati	**33.29%**
	Muslim/Terai Caste and others	**22.82%**
Location of household	Rural area	**35.23%**
	Urban area	**64.77%**
Province of household	Province 1	**16.24%**
	Province 2	**22.24%**
	Province 3	**19.27%**
	Province 4	**7.43%**
	Province 5	**18.63%**
	Province 6	**6.4%**
	Province 7	**9.8%**
Total number of observations = 6224		

Table 4 presents the differences in Child's stunting (HAZ) across the categorical variables that we have analyzed in the study. We have computed the statistical significance of the differences by using a t-test (for categorical variables with two levels) and a Bonferroni correction test (for categorical variables with more than two levels), as explained in Section 3.4.2.4.

Table 4: Child's HAZ by Categorical Variable

Variable	Mean HAZ	Difference in HAZ
Child's Gender		
Male	-1.21	*t-test results*
Female	-1.12	*Male vs Female: -.08**
Child had diarrhoea		
Yes	-1.34	*t-test results*
No	-1.14	*Yes vs No: -.19****
Place of delivery for child		
Home	-1.36	*Bonferroni test results*
Government hospital	-1.06	*Government VS Home: 0.30****
Private and others	-0.81	*Private VS Home: 0.55****
Mother's Education		
None	-1.38	*Bonferroni test results*
Basic education	-1.27	*Basic vs None: 0.11**
Secondary and others	-0.98	*Secondary vs None: 0.40****
Gender of Household Head		
Male	-1.16	*t-test results*
Female	-1.19	*Male vs Female: .03**
Caste of Household Head		
Brahmin	-1.16	*Bonferroni test results*
Dalit	-1.29	*Dalit vs Brahmin: -0.13**
Janajati	-1.06	*Janajati vs Brahmin: 0.09*
Muslim/Terai Caste	-1.26	*Muslim/ Terai vs Brahmin: -0.10*
Location of household		
Rural area	-1.30	*t-test results*
Urban area	-1.06	*Rural vs Urban: -0.24****
Province of household		
Province 1	-0.96	*Bonferroni test results*
Province 2	-1.12	*Province 3 vs 1: -0.07*

Province 3	-1.04	*Province 3 vs 2: 0.08*
Province 4	-0.99	*Province 3 vs 4: 0.04*
Province 5	-1.27	*Province 3 vs 5: -0.23****
Province 6	-1.49	*Province 3 vs 6: -0.45****
Province 7	-1.40	*Province 3 vs 7: -0.36****

Source: Author's own elaboration;

* p < 0.05, ** p < 0.01, *** p < 0.001, ns: not significant at 5 % significance level

Table 4 indicates that, on average, male children are significantly shorter than female. Further, we also find that children with a reported incidence of diarrhoea are significantly shorter. Therefore, we expect that children with a better household health environment, which is proxied by the incidence of diarrhoea in our analysis, have a significantly better nutritional outcome. Table 3 also highlights the expected positive contribution of mother's education in reducing child stunting compared to those with no education. We also find that children delivered in a healthcare facility are expected to have a significantly higher HAZ as compared to those delivered at home. Regarding caste or ethnicity, our results in Table 4 suggest that Dalit children, on average, are significantly disadvantaged in terms of HAZ as compared to their Brahmin counterparts.

Finally, Table 4 suggests that the child's HAZ also differ by the location of the household as we find that children, on average, are significantly shorter in rural areas. Similarly, we also find that child stunting is significantly higher in Provinces 6 and 7 than in Province 3. It should be noted that Provinces 6 and 7 are relatively less developed as compared to all other Provinces, and Province 3 is the most developed region in Nepal. This observation is in line with the study conducted by Angdembe et al. (2019), who highlighted the within-country inequalities in child stunting. Their study asserted that in 2016, child stunting was more prevalent in Province 6 than the others.

4.3 Model Fit Statistics

At the outset, we present the model fit statistics for each of the models in Table 5. The model numbers in Table 5 correspond to the equation number of models specified in the discussion of the econometric strategy in Chapter III.

Table 5 indicates the results of various tests that we performed in relation to the statistical fit of our models. As previously indicated in Section 3.4.2.4, we first tested for the possible functional misspecification in the model using Ramsey's Regression Specification Error Test, followed by the link test to check for the possible omitted variable bias. A non-significant value of the Ramsey Test statistics and Specification Test (Hat squared) statistics indicates that the model is correctly specified. In the table, our final model (Model 6) is non-significant for both of these tests, which indicates that the underlying and the basic factors that we have included in our final model are correctly specified.

Second, the R-squared and adjusted-R-squared values of each of our models range from 4 % in Model 1 to 14% in Model 6, which means that child's age in model 1 only explains 4 % of the variation in child stunting in model 1 while we explain 14 % of the variation after accounting for all relevant underlying and basic factors in Model 6. This result confirms that each tier of determinants, corresponding to the UNICEF (1990) framework, better contributes to explaining the outcome variable (child's HAZ). This conclusion is also confirmed by lower values of AIC, BIC, and Root mean square error values for each successive model.

Third, we also performed Wald tests for each successive introduction of determinants in our models. The statistical significance of Wald test statistics strongly indicates that each of the determinants introduced in the successive models improves the overall fit of the model and are important in explaining the child stunting.

Finally, we also tested for multicollinearity issues in our models by computing the Variance Inflation Factor (VIF) after computing each model in STATA as described in (Baum, 2006; Agresti & Finlay, 1979). More specifically, we also tested the correlation between wealth score and mothers' education by running VIF in models 5 and 6. All the VIF values were in the acceptable range as suggested in the literature (Baum, 2006; Agresti & Finlay, 1979).

Table 5: Model Fit Statistics

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ramsey's Regression Specification Error Test	23.31***	26.16***	27.13***	7.34***	4.15**	1.00 (ns)
Link Test (Hat sqaured value)	1.978***	1.465***	1.411***	.328**	.156 (ns)	0.123 (ns)
R-Squared	0.0402	0.0479	0.049	0.112	0.127	0.144
Adjusted R-Squared	0.040	0.048	0.049	0.110	0.124	0.138
Root Mean Square Error	1.228	1.223	1.222	1.236	1.226	1.216
F-Statistic	162.61*** (df = 6222)	97.29*** (df = 6221)	67.60*** (df = 6220)	43.39*** (df = 3012)	33.05*** (df = 3007)	20.02*** (df= 2996)
AIC	20219.02	20170.76	20164.96	9852.492	9801.104	9763.31
BIC	20232.49	20190.96	20191.90	9894.58	9861.22	9801.57
Wald Test for Additional Variable(s)	162.61***	32.97***	5.23**	8.52***	10.92***	4.45***

Source: Author's own elaboration

* p < 0.05, ** p < 0.01, *** p < 0.001, ns: not significant at 5 % significance level

4.4 Results and Discussion:

Table 6 presents the results of the models estimated in our study. The overall presentation of the estimated results is based on the sequence to which we introduced variables related to the underlying and basic determinants of child stunting, corresponding to the UNICEF (1990) conceptual framework.

Table 6: Regression Results

Dependent Variable: HAZ	Estimated Models					
	(1)	(2)	(3)	(4)	(5)	(6)
Child Characteristics						
Child age	-.015***	-.014***	-.014***	-.017***	-.017***	-.016***
	(.001)	(.001)	(.001)	(.002)	(.002)	(.002)
Child age-squared		.118***	.118***	.209***	.214***	.219***
		(.021)	(.021)	(.032)	(.032)	(.032)
Child is female			.087*	.206***	.212***	.216***
			(.038)	(.055)	(.055)	(.055)
Underlying Causes						
Household Environment						
Child had Diarrhea				.162	.109	.09
				(.084)	(.084)	(.082)
Adequacy of Health services:						
Place of Child Delivery						
Government Hospital				.24***	.104	.117
				(.064)	(.067)	(.068)
Private and others				.438***	.221*	.198
				(.1)	(.106)	(.105)
Basic Causes						
Mother's Education						
Basic					.133	.095
					(.077)	(.08)
Secondary and Higher					.163*	.102
Household Living Standard						
					.151***	.123**
Wealth Score					(.031)	(.038)

Dependent Variable: HAZ	Estimated Models					
	(1)	(2)	(3)	(4)	(5)	(6)
Social, cultural, and political						
Gender of Household-Head						-.061
						(.069)
Caste and Ethnicity						
Dalit						-.083
						(.081)
Janjati						.002
						(.074)
Muslim/Terai/Others						-.221*
Rural and Urban Context						
Urban						-.084
						(.058)
Province-level context						
Province 1						.251**
						(.097)
Province 2						.093
						(.112)
Province 4						.075
						(.102)
Province 5						-.173
						(.093)
Province 6						-.134
						(.109)
Province 7						-.257*
						(.1)
Constant	-0.672***	-0.825***	-0.865***	-1.424***	-1.409***	-1.264***
	(0.043)	(0.047)	(0.051)	(0.116)	(0.123)	(0.154)
Obs.	6224	6224	6224	3019	3017	3017

Source: Author's Own Elaboration. Standard errors are in parenthesis

*** $p<0.001$, ** $p<0.01$, * $p<0.05$

4.4.1 Results on Child-level Characteristics

The first three models (Models 1-3) sequentially introduce child-level characteristics (child age, squared age variable and child gender) that are controlled in all the latter models, as indicated in Table 6. Our result highlights that child's age is significantly and negatively associated with a child's HAZ across all the models.

However, as a child's age increases, the HAZ score cannot decrease perpetually. So, there is a possibility of a non-linear relationship, which is, thereafter, tested with the introduction of the squared age variable in the later models. The significant age squared variable in all the models strongly indicate that with an increase in child age, the HAZ score decreases only until some point and then eventually increases. The significant non-linear relationship as observed in our estimation is also confirmed by the literature (Sassi, 2018, MoHP, NEW ERA, et al. 2012), where the authors have found out that there is an inverse relationship between child's age and stunting, and that child's HAZ begins to increase at the age of 36-37 months.

Similar results were also found in regard to child's age in other studies conducted in Tanzania, Ghana, Ethiopia and Bangladesh (Chirande et al., 2015; Ali, Saaka, Adams, Kamwininaang, & Abizari, 2017). Dorsey et al. (2018), in their study in Nepal, also reported that children of older age had a lesser probability of being stunted. Wali et al. (2020), in their study conducted in South Asian countries like Bangladesh, India and Nepal, explained that one of the reasons behind the inverse relationship between HAZ and age could be the changes in breastfeeding periods, as most children in this region are breastfed until 24 months and are then gradually discontinued in the latter years.

The third child-level characteristic introduced in model 3 is the child's gender which has been added to assess child-level gender discrimination in child nutritional outcome. Our results from model 3 – model 6 suggest no evidence of gender discrimination in child nutritional outcome, at least, at the child level. In fact, we find that female child, on average, is 0.21 standard deviation taller than the male children, even after controlling for the underlying and basic factors of child stunting. Similar results were also found in previous studies conducted in Nepal (Dorsey et al., 2018; Ministry of Health and Population (MOHP) [Nepal]; New ERA; and ICF International Inc, 2012; Van Tuijl et al., 2020) and in Vietnam, Ghana, Tanzania, Ethiopia, Cambodia, and India (Akombi et al., 2017; Ali et al., 2017; Chirande et al., 2015; Nguyen Ngoc Hien, 2008).

Few possible reasons for the surprising outcome of male children being more stunted than girls, according to Marcoux (2002), is that the female children cope better with the lack of food supply than the boys due to their nature of bodily development and physiological factors. Wells (2000) adds further that males are more vulnerable to environment-related stress favoured by the process of natural selection than females, and the result is more prominent in the most socio-economically disadvantaged groups.

4.4.2 Results on Underlying Determinants of Child Stunting

After analysing child-level characteristics, we then moved to investigate the underlying factors of child stunting based on the UNICEF (1990) framework. To that, model 4 introduced two variables: incidence of diarrhoea in children as a proxy for household-level environment and place of child's delivery as an indicator for adequacy of maternal and child-care and feeding practices. Prevalence of diarrhoea and place of delivery were also used as proxies for factors related to water and sanitation facilities (WASH) and child care practices in the household in the literature (Babu, S. C., Gajanan, S. N., Hallam, 2017).

In our study, we did not find any significant relationship between household health environment and child's HAZ. However, previous studies in Nepal, such as Checkley et al. (2008) have reported that the prevalence of diarrhoea increases the risk of stunting. Their study reported that infections and intestinal parasites frequently occur among mothers and children and are a major health concern for their nutritional outcome. In the 2014 Nepal Multiple Indicator Cluster Survey (NMICS), about 12% of the under-5 children reported having suffered diarrhoea. The survey found that the level of awareness among families was also a concern as parents, especially in rural areas, tend not to seek medical professionals' help, thereby increasing the health risk for their children. For example, only 47% of parents got help from a medical professional in the incidence of disease or infections in children in 2015 in Nepal ("Multi-sector Nutrition Plan II (2018-2022)," 2017).

Nonetheless, in our study, the non-significance of the household health environment might also be due to the choice of incidence of diarrhoea as a proxy variable. We tried several other proxies, including improved cooking stoves, availability of improved toilet, access to improved source of drinking water, and waste disposal sites at the household level. However, the results remained the same. Considering that, we decided to keep the incidence of diarrhoea as a control for the

household's health environment as it best captures the short-term child-level outcome occurring due to any of the above alternative proxies.

Regarding 'place of delivery', which proxies maternal and childcare, we observe that HAZ is significantly higher for children born at a healthcare facility as compared to those born at home in model 4. In fact, the positive effect of being born in a private healthcare facility is even higher than that of a government healthcare facility. The finding is also reported in the study by (Chirande et al., 2015), where delivering the child at home with the traditional birth attendants made households more prone to severe stunting in Tanzania due to lack of awareness and proper feeding practices. In Nepal, mother's and child care practices constitute other contextual issues like pregnancy at early-age, too many pregnancies in shorter intervals and lack of medical attendance at birth, which further increase the risk for maternal and child's health, especially in rural areas ("Multi-sector Nutrition Plan II (2018-2022)," 2017).

However, as we introduce basic causes of child nutrition in model 5, we only observe the significant positive effect of a private healthcare facility, albeit at a lower magnitude. Since the variable 'place of delivery' is also a proxy for household-level awareness to access health care facilities, it is possible that the variable loses its significance and explanatory power for households with similar levels of mother's education and household living standard as they might share similar levels of health awareness. Moreover, in model 6, we do not observe any significant effect of place of delivery once we account for the contextual factors in reference to the location of the household. The concentration of healthcare facilities in the urban area in Nepal and more so in Province 3 might have contributed to further reduction of the explanatory power of the variable.

4.4.3 Results on Basic determinants of Child Stunting

We incorporated the basic determinants of child stunting in our analysis in models 5 and 6. The introduction of basic determinants in the two models allows us first to analyze the household-level basic conditions in model 5, and then observe the overarching effects of contextual factors in model 6.

In model 5, we observe that mother's education has a positive effect on a child's nutritional outcome. A similar result was also reported in (Chirande et al., 2015) where the authors stressed the importance of mothers' education to reduce child stunting. (Hossain, Niroula, Duwal, Ahmed,

& Kibria, 2020) in their study also suggested that the malnutrition rates could be decreased by improving the socio-economic conditions of their mothers, including their education, occupation, and income status.

However, the effect of mother's education is only significant in model 5, more specifically for those with secondary or higher levels of education. On average, children born to mothers with secondary or higher levels of education were 0.16 standard deviation taller than those born to mothers with lower levels of education. We also tested for the possible collinearity between mother's education and household-level wealth score. However, we did not observe any substantial collinearity issues in the estimated model. The non-significance of mother's education in model 6 indicates that the contextual factors of the households largely negate the positive effect of mother's education.

Regarding household living standard, we find that wealth-score significantly explains child stunting. Previous studies also reported that the families with lower income level tend to have a higher tendency of child stunting (Carlos Augusto Monteiro et al., 2010; Delpeuch, Traissac, Martin-Prével, Massamba, & Maire, 2000; Hong, Rathavuth; Mishra, 2006; Nepali, Simkhada, & Davies, 2019; Reyes et al., 2004). In our analysis, in model 5, we expect that 1 standard deviation increase in wealth score significantly raises the child's HAZ by 0.15 standard deviation. Wealth score remains significant in model 6 even after controlling for the contextual factors, however, with a lower magnitude. This result indicates that while household living standard does matter for child nutritional outcome, its effect is highly contingent on the contextual factors.

Finally, we introduce variables related to the household-level social and cultural context, as proxied by the household head's gender and caste or ethnicity and other location-specific contextual factors. Dorsey et al. (2018), in their study, had reported that female-headed households tend to have a decreasing effect on HAZ score. However, in our analysis, we find that the difference in child stunting between the male-headed and female-head households that we earlier observed during the t-test in Section 4.2 does not remain statistically significant once we control for all the underlying and basic determinants. We also observe similar results on the child stunting difference between the rural and the urban households. We had earlier found a significant difference between rural and urban areas in our t-test in Section 4.2. However, our regression analysis reveals that the difference turns insignificant once we equalize the underlying and basic

factors of child nutritional outcome between these two areas in model 6. A previous study that found significant rural-urban child stunting differences in Nepal and Bangladesh (Srinivasan, Zanello, & Shankar, 2013) had concluded on the need for an equalization of the levels of determinants to minimize the rural-urban differentials. Our findings are, therefore, in line with the previous study and confirms their policy recommendation.

Our final model 6 provides us with the following two additional important insights on the most disadvantaged groups of households in terms of child stunting. One, our results indicate that Muslim and other Terai ethnic communities are the most disadvantaged group in child nutritional outcome. A previous study in Nepal had found that the probability of a child being underweight was higher for children belonging to Muslim/Terai/others group than other so-called upper castes (Bishwakarma & Vanneman, 2011; Prasad Pandey, 2011). Nepal has a complex ethnicity/ caste structure, as explained in Section 2.3.1, which often hampers the socio-economic wellbeing of the marginalized caste groups (Pradhan & Shrestha, 2005). Bishwakarma & Vanneman (2011) also add that Dalit and Muslim/ Terai children are more disadvantaged than those belonging to other castes due to the socio-cultural context of Nepal, which creates inequities within the caste hierarchy. Our results confirm the previous literature (Pradhan & Shrestha, 2005) that the caste system continues to favour the high-caste group (Brahmins and Chhetris) due to their higher access to the country's resources, which enables them to achieve a higher nutritional outcome for their children as compared to the marginalized groups.

Second, we find that households in Province 7 are significantly disadvantaged in comparison to all other provinces. The province, also known as 'Sudurpaschim province', is one of the least developed regions in the country. Previous studies (Pradhan & Shrestha, 2005; Sanjib Dhungel, 2018) report that Province 7 has the lowest rank in Human Empowerment Index, Gender Development Index and economic index out of all the provinces. Hence, a significantly lower nutritional outcome in Province 7 is not surprising. In this context, our final model suggests that the upcoming policies and programs to reduce child stunting should be focused on the most disadvantaged region (Province 7) and population-group (Muslim/Terai and others).

Chapter V: Conclusion and policy recommendations

In this study, we analyzed the basic and underlying determinants of child malnutrition in Nepal. The major findings of the study are that child's age, gender, place of delivery, standard of living, caste or ethnicity, and province are the main predictors of child nutritional status in Nepal.

The findings of our study imply that the household's access to proper health care facility, levels of relative wealth or living standard, caste or ethnicity (especially for Muslim, Madhesi/ Terai and other minorities), and provincial level differences should be taken into account while devising equitable policy interventions to reduce the problem of child malnutrition in Nepal. The findings of the study further stress that the gaps in the quality of health care services between government, private and otherwise make it more likely that children from wealthier households have better access to the private institutions and, therefore, have lesser chances of child stunting. This reality confirms the importance of achieving healthcare equity as one of the urgent requirements while working towards children's overall health.

The findings of our study are even more important considering the current COVID-19 pandemic and the post-earthquake scenario. Our study recommends that Nepal, being one of the highly COVID-affected countries in South Asia, should ensure that the country's policy mechanism prioritizes the most disadvantaged groups and geographical region in implementing child malnutrition interventions. The current health infrastructure, social differentiation, and, more importantly, inequality in living standards could threaten Nepal's progress in its child nutritional goals. For this reason, our study recommends that policymakers consider these aspects in implementing nutrition policies, as confirmed by the previous literature (Akseer, Kandru, Keats, & Bhutta, 2020).

Finally, our study also calls for further research in investigating and devising the most urgent child nutritional policies considering the current COVID-19 situation while considering Nepal's contemporary socio-economic context, as demonstrated in this study.

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