Vol. 9, No. 1, 2023 (May) 75–84
The Journal of Knowledge and Innovation
Journal homepage: https://www.nepjol.info/index.php/JKI
Publisher: Research Management Cell , Mahendra Morang A. M. Campus (Tribhuvan University) Biratnagar

Factors associated with Childhood Anthropometric Measurements in Nepal: A Provincial-Level Analysis Based on NDHS Data 2016

Ram Prasad Dhakal
Centre for Population and Development (CPAD), Purbanchal University, Nepal
Email: rppu.dhakal@gmail.com

Abstract

The study assesses the prevalence of and factors affecting the anthropometric measurements i.e. stunting-HAZ, wasting-WHZ and underweight-WAZ each below -2 SD from the median of the reference population, among children below 5 years of age group in newly structured seven Provinces of Nepal by different background characteristics using Nepal Demographic and Health Survey (NDHS) Data, 2016. Anthropometric indicators are far worse in Madhesh and Karnali provinces than the national average. The highest share of stunted children is in Karnali Province whose size at birth is very small (70%) against the national average of 36 percent. Children in the poorest quintile and born from illiterate mothers of Madhesh Province and Karnali Province have highly suffered from stunting. Data shows that children born to illiterate mothers are highly wasted in Madhesh Province (23.8%). Underweight increased with an increase in the age of the children; increases with birth order in all Provinces. Except Gandaki Province, underweight is more common in rural areas than in urban areas. The prevalence of underweight children is the highest in the poorest quintile of Madhesh Province i. e. 50 percent as compared to the national average of 27 percent. High birth order has significantly contributed to worsening childhood nutrition. The statistical test infers that childhood stunting and underweight are in aggregate strongly related to all variables except sex while wasting is strongly associated with only children's age and their mother's education. The author suggests applying provincial policies and programs based on the findings to tackle their poor anthropometric indicators.

Keywords
Anthropometry, Wasting, Stunting, Underweight, Factors associated.

Article information
Manuscript received: March 8, 2023; Accepted: May 4, 2023
DOI https://doi.org/10.3126/jki.v9i1.53074

1 Introduction

Anthropometry refers to the part of human sciences which deals with body measurements for instance body size, shape, strength, mobility, flexibility as well as working capacity [1]. The key components of anthropometric measurements are height, weight, body mass index (BMI), circumferences of the waist, hip and limbs etc. These measurements are important as they refer to the measurement of children's nutritional status. In children, the key anthropometric measurements incorporate stunting, wasting and being underweight. Stunting refers to children who suffer from low height for their age, wasting refers to those with a low weight for height, and underweight stands for those with a low weight for age. Mid-upper arm circumference (MUAC) and BMI are some of the important measurements as markers of childhood nutritional status. The accuracy of the measurements can improve the outcomes of anthropometry [2].

Nutrition is an inevitable component of children's growth and overall development which contributes magnificently to reducing the risk of death of children. Anthropometry is the tool to determine and monitor the nutritional status of children. At the individual level, anthropometric data are useful for care and treatment; the design, implementation, monitoring, and evaluation of nutrition programmes and policies, as well as resource distribution. At the population level, the anthropometric indicators are measured as prevalence level i.e. percent of the population. Practitioners can apply the public health prevalence thresholds of these indicators to identify the magnitude of the nutrition problem. The economic, climatic, food security and health trends are some of the determining factors for these indicators [3].

Although there has been some improvement over the years, Nepal still has poor anthropometric indicators. In 2016, there was a high prevalence of childhood stunting (36%) and underweight (27%), as well as a poor prevalence of wasting (10%) when compared to the standard threshold set by the WHO. There is widespread socio-economic inequality and uneven distribution of resources and health providers which aggravate inequality in the anthropometric outcome. About 53 percent of Nepalese children aged 6-59 months age suffer from anaemia (Ministry of Health et al., 2017). Similarly, the high prevalence of stunting, wasting and being underweight among children is a challenging issue in Nepal. Food insufficiency is also one of the serious issues in poor and distant children. Government should take responsibility and make provisions for adequate food for them. The food habit, breastfeeding practices and proper nutritious food indicate the nutritional status of the children. The provincial level analysis of children's anthropometric measures will help to suggest for program intervention to uplift the status of the children.

The growth faltering is one of the challenging public health issues in most developing countries mainly in Asian and sub-Saharan African countries. The growth faltering is inherently related to cognitive and physical problems, morbid conditions as well as death [4]. The anthropometric measurements are inevitable tools to conduct the follow-up and early diagnosis process. The important parameters of anthropometry are mostly age, height, weight, MUAC, and Z scores for weight for age (WAZ), weight for height (WHZ), and height for age (HAZ). Research conducted in Malawi declares that growth faltering is widespread in supposedly healthy children who attain the vaccination clinic. It is recommended that anthropometric measurements should be introduced in routine child care to provide useful interventions to those who require them [5].

The weight of hundreds of thousands of children is measured daily; the height and MUAC of slightly fewer are also measured daily. For accurate measurement, nutritionists or health workers working in the field of nutrition should have adequate core skills in anthropometric measurements [6].

Stunting, wasting and being underweight are mostly applied for analysing health as well as mortality risk, but these provide very confined evidence on the association between malnutrition and disease. Stunting which stands for inadequate skeletal growth is a marker of chronic malnutrition. Wasting which indicates the loss of fat and lean tissue is a symptom of further acute malnutrition. Being Underweight is caused by either stunting or wasting or is a product of their combinations. Each of the indicators is precious information on certain biological processes which seek specific clinical responses [7]. Weight is one of the key measurements in nutritional assessment. It is the most important variable for predicting macronutrient and fluid requirements and a valuable index in acute malnutrition. Similarly, the measurement of height is required for computing many indices for instance HAZ, WHZ, WAZ AND BMI etc [8].

There are different consequences of weak anthropometric measurements like underweight, stunting and wasting. Evidence shows that the mortality risk has increased even in mild underweight children and greater risk in severely underweight children. Poor diet and frequent infection in children promote their growth retardation and ultimately lead to a higher risk of illness and death. Stunting which is a result of long-term nutritional deficiency can further lead to delayed mental development, poor school performance and reduced intellectual capacity. This hurts the macro-level economic productivity of a country. Similarly, wasting among children is an indication of acute undernutrition which is caused by a low diet or a frequent incidence of infectious diseases like diarrhoea. Wasting hampers children's immune systems and increases the severity as well as the duration of and susceptibility to communicable diseases and ultimately a high risk of death [9].

The analysis of surveys on the prevalence of undernutrition among children of age 0–4 years conducted in 112 countries revealed that underweight mothers and children contributed 34.7 percent of all deaths of 0-4 years children. There was a high loss in disability-adjusted life years (DALYs) related to these deaths [10]. Overweight children also have many adverse impacts. A study conducted by the Minneapolis children's blood pressure study in Kingston, Jamaica found that there is a significant association between childhood weight (BMI) and total cholesterol levels in adulthood [11].

The aforementioned facts are only a few examples indicating the impacts of worse childhood anthropometry; they have other many diverse impacts. As the prevalence of anthropometric measurements is still high, the paper tries to explore their probable causes at the population level. Very few researches have been conducted in different provinces of Nepal childhood anthropometric measurements. The paper tries to minimize the research gap in this area. This may be useful from the programme intervention as well as the eye-opening for the further area of research with more sophisticated statistical analysis.

The objective of this study is to analyse the prevalence of and factors responsible for stunting, wasting and underweight among children under-five years in different provinces of Nepal based on NDHS data, 2016. Only the three major indicators stunting, wasting and underweight are tried to explore here and many were left due to the sample size as well as space constraints. Other indicators are left for future researchers. Moreover, limited statistical analysis is used in this paper due to the small sample size problem. Likewise, data were drawn from only one round of the survey.

2 Methods and materials

Nepal NDHS 2016 data of kids file (KR) is used for data analysis. The dependent variables incorporated in the paper are: Stunting: HAZ (HW70), Underweight: WHZ (HW71), Wasting: WAZ (HW72) whereas the independent variables incorporated in the paper are Age of child (B19), Sex of child (B4), Birth order (BORD), Birth interval (B11), Size of the child at birth (M18), Breastfeeding status (V404), Residence (V025), Mother's education (S108), Wealth index (V190). Here the symbols in the parentheses refer to the question number of variables in the NDHS dataset.

The children under age 5 whose height and weight were measured are taken as the unit of analysis. The constraint of the data analysis is that it has used only kids-file in studying the background variables which can be extended to the variables incorporated in other files as well. The inconsistencies, do not know and missing values are excluded from all dependent variables in the analysis. The dependent variables mentioned above i.e. HAZ, WHZ and WAZ are calculated by applying the Z-score below minus two standard deviations (-2 SD) from the median of the reference population. These indices below -3SD from the median i.e. severe condition as well as from above +2SD from the median i.e. overweight are not analysed here as the sample for this analysis is small in the context of Nepal and could not be analysed further into the Province level.

In terms of independent variables, do not know the category is excluded from the size of the child at birth. The birth order variable was formed by applying the logic of birth order = BORD. If (B0 > 1) birth order = BORD - B0 + 1, where B0 is the variable 'The child is twin'. Similarly, birth interval= B11 is the preceding birth interval in the NDHS file. But if (birth order = 1), the birth interval is made first birth [12]. All the dependent variables and some of the independent variables are recoded as per the need in the analysis. The distribution of the children by anthropometric measurement is presented below in Figure 1.

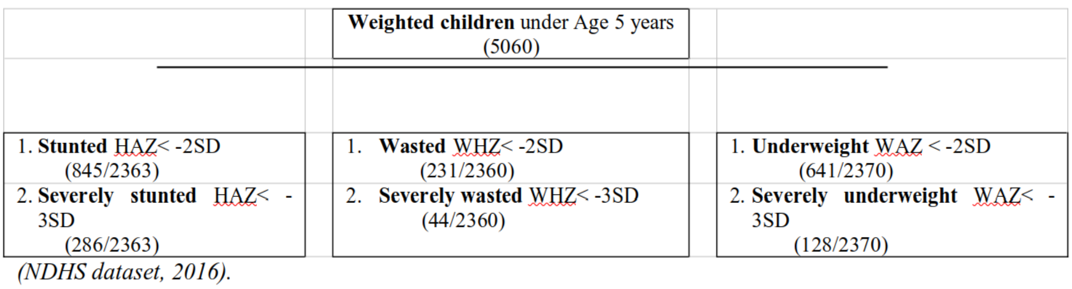

Figure 1: Sketch of the study population of age under five children.

The statistical package for social sciences (SPSS-20) is used for data processing. The basic statistical test i.e. chi-square test is used for data analysis. Due to the low sample size, other statistical tests for determining the factors responsible for the anthropometric measurement are not applied here.

The chi-square value is estimated by using the formulae:

$$\chi^2 = \sum_{i=1}^{n} \left[\frac{\left(O^i - E^i\right)^2}{E^i} \right] \tag{1}$$

where, χ^2 = chi-square value, O^i = observed value, and E^i = expected values of the data [13].

3 Results

This section deals with the prevalence of stunting, wasting and underweight based on below -2SD for national as well as provincial-level analysis. The provincial-level numbers of children in different categories of the variables are not presented in the tables, though the figure for Nepal is presented in the tables. Similarly, the total number of children in each province is also presented in the tables.

3.1 Stunting

Table 1 indicates the prevalence of stunting of children below 5 years in different provinces of Nepal by background characteristics. Though the trend of stunting in Nepal has decreased from 57 percent in 1996 to 36 in 2016 [14], still it remains in the range of high prevalence of childhood stunting when compared with the WHO standard. Moreover, in categories, the prevalence of stunting is worst as reflected in Table 1.

It reveals that stunting of children was very high in the age group 12-59 months as compared to 0-11 months in all Provinces. Among the 12-59 months children, the highest stunting was found in Karnali province as compared to other Provinces. There is a significant association between the age of the children and their stunting in all of the Provinces and Nepal as well. On the other hand, there is no variation in childhood stunting by sex in all the provinces as well as Nepal. Increasing birth order in general increases the risk of stunting in all Provinces. There is a statistically significant association between birth order and childhood stunting only in Nepal, Madhesh Province and Bagmati Province. Except for Bagmati Province, increasing birth interval, in general, decreases the prevalence of stunting. There is a strong statistical association between birth interval and stunting in Nepal and Koshi Province, though there is an association in Bagmati Province in the reverse direction as data indicated.

Except Koshi Province, the child whose size at birth was very small has a high prevalence of stunting as compared to those whose birth size was large. There is a statistically significant association between the size of the child at birth and the stunting of children in Nepal and Karnali Province. As a controversy, data reveals that the children who are breastfeeding are more stunted as compared to those who are not breastfeeding in other Provinces except Bagmati Province. This is a further issue of research. There is a strong statistical association between breastfeeding status and children's stunting in Koshi Province and Bagmati Province. Except Sudur Paschim Province, children in rural areas are more stunted than in urban areas. There is a statistically significant association between residence and childhood stunting only in Nepal and Bagmati Province. An increase in mothers' education decreases stunting in all Provinces of Nepal. There is a strong statistical association between mother's education and children's stunting in Nepal, Madhesh Province, Bagmati Province and Lumbini Province. Though there are some controversial findings, as the level of wealth index increases, the stunting of children in general decreases in all provinces of Nepal. There is a statistically strong relationship between wealth index and children's stunting in Nepal, Koshi Province, Madhesh Province, Bagmati Province and Lumbini Province. In some provinces, the statistical association could not be measured due to low expected frequency in some of the cells.

3.2 Wasting

Though the wasting of children under five years of age has decreased over time in Nepal, from 15 percent in 1996 to 10 percent in 2016 [14], it remains in the poor range of childhood wasting as of the WHO standard. Table 2 presents the prevalence of wasting in provinces by background variables.

It indicates that the prevalence of childhood wasting is very high below the age of 0-11 against 12-59 months in all Provinces which is just reversed with the stunting pattern. The highest prevalence of wasting is found in Madhesh Province in ages 0-11 months which is situated in the plain area. There is a strong likelihood of childhood waste with their age in Nepal, Koshi Province and Madhesh Province as shown in Table 2. There is no specific pattern of prevalence of childhood wasting by sex in different Provinces of Nepal. The highest prevalence of wasting in females is in Koshi Province and Madhesh Province while the highest wasting in males is in Sudur Paschim Province. Similarly, except Bagmati Province, the prevalence of wasting is more in high-order births. On the other hand, wasting has no particular pattern by the birth interval.

Except for Bagmati Province, Gandaki Province and Lumbini Province, other Provinces have a high prevalence of childhood stunting if the size of the child at birth is very small.

As unexpectedly, there is a low prevalence of childhood waste among those who are not breastfeeding as compared to those who are breastfeeding. There is a significant association between childhood waste and breastfeeding status in Nepal and Lumbini Province. Wasting of children does not differ much by their place of residence. There is no uniform pattern of stunting with the mother's literacy. Among all strata of mothers' education, there is the highest prevalence of stunting of children (i.e. 23.8%) in the poorest quintile of Madhesh Province. There is a strong statistical association between childhood waste and mothers' education in Nepal and Koshi Province. The prevalence of childhood wasting does not follow any specific pattern with the wealth index in Nepal and different Provinces. Wasting is highest in the poorest wealth group in Madhesh Province. In sum, there is no significant association of childhood stunting with the sex of the child, birth order, birth interval, size of child at birth, residence as well as wealth quintile.

3.3 Underweight

Table 3 reveals the prevalence of underweight children below 5 years of age in Nepal and its provinces by background characteristics. Though there is a decreasing trend of childhood underweight in Nepal from 42 percent in 1996 to 27 in 2016 [14], Nepal still suffers from the high prevalence of childhood underweight as to WHO standards.

It indicates that underweight in children significantly increases with increase in their age in Koshi Province, Madhesh Province and Bagmati Province. The highest childhood underweight was found in Madhesh Province of the age group 12-59 months. There is no significant association of underweight by sex in Nepal and different Provinces. The highest underweight was found in either sex of Madhesh Province. Underweight increases with an increase in birth order in Nepal and all Provinces. The highest underweight was found in Province two of birth order 4+ i.e. 44.4 percent followed by Karnali Province i.e. 43.3 percent in birth order 4+. There is a significant association between childhood underweight with birth order in Nepal, Madhesh Province and Bagmati Province. Except for Koshi Province and 2, all other Provinces suffer from high childhood underweight in short birth intervals of below 2 years. The highest underweight was found in Karnali Province of the birth interval of below 2 years. There is a statistically significant association between childhood underweight and birth interval only in Nepal and not in provinces. Except for Lumbini Province, other Provinces face high childhood underweight if the size of the child at birth was very small. There is a statistical association of childhood underweight with the size of the child at birth only in Nepal and Lumbini Province.

Surprisingly, there is more prevalence of underweight among children who are breastfeeding as compared to those who were not breastfeeding in other provinces except for Bagmati Province. Moreover, there is a significant relationship between childhood underweight and breastfeeding status in Nepal, Koshi Province and Lumbini Province. Underweight is, in general, more in rural areas as compared to urban areas in all Provinces though it is the same in Gandaki Province. There is a significant association between childhood underweight with residence only in Nepal. Except for Bagmati Province and Sudur Paschim Province, there was high underweight of children born to illiterate mothers. There is a statistically significant relationship between childhood underweight and a mother's education in Nepal, Koshi Province, Bagmati Province and Lumbini Province. Except for Koshi Province and Lumbini Province, more children are underweight in the poorest wealth quintile. Underweight was highest in the poorest group in Madhesh Province i.e. 50 percent. There is a significant association between childhood underweight and wealth quintile only in Nepal and Lumbini Province.

4 Discussion

This part covers some important empirical findings on anthropometric measurements especially stunting, wasting and underweight of children under five children in different areas of the world for making more valid for the findings.

The findings suggest that there is a consistent pattern of increased undernourishment as age of children increases in all provinces of the country. This is a problem that is not unique to Nepal, as a similar study in Kenya found that children aged 6-59 months are more likely to be underweight compared to younger children who are exclusively breastfed [15]. Furthermore, a study conducted in Nigeria also indicates that age is a significant factor in determining the prevalence of underweight among children [16]. These findings highlight the importance of providing children with adequate nutrition during their critical early years to promote healthy growth and development.

The measurement tools also differ in the prevalence of anthropometric measures like stunting, wasting and underweight of the population. For instance, there was a higher prevalence of stunt-

Table 1. Prevalence of stunting (short for age below -2 SD) of children below 5 years in different Provinces of Nepal by background characteristic, 2016.

Characteristics	Children's height measured (Nepal)	Prevalence of stunting							
		Nepal	Koshi	Madhesh	Bagmati	Gandaki	Lumbini	Karnali	Sudur Pashchim
Age of child									
0-11	467	15.9	17.6	15.9	3.1	13.2	19.8	30.0	15.8
12-59	1895	40.6	37.0	40.9	36.5	33.3	43.0	60.8	40.1
χ2 value		98.790***	11.202**	25.131***	27.601***	5.929*	17.187***	9.207**	7.992**
Sex of child									
Male	1234	35.8	33.7	36.5	28.7	31.2	37.7	55.6	35.7
Female	1128	35.7	31.4	36.6	32.5	25.9	38.3	54.4	34.8
χ2 value		.004	.213	.001	.615	.634	.017	.019	.019
Birth order									
1	900	30.5	30.5	37.7	20.8	24.2	29.5	47.2	30.6
2-3	1079	35.8	34.4	31.2	33.5	32.5	40.8	56.7	33.3
4+	384	48.3	34.0	46.4	55.0	42.9	53.2	65.5	48.7
χ2 value		37.147***	.795	9.239*	18.926***	2.776	NA	2.689	3.942
Birth Interval									
First birth	902	30.5	30.5	37.7	20.8	24.2	29.5	47.2	30.6
0-23 months	303	42.9	47.6	34.5	38.1	54.5	52.8	63.6	48.3
24-47 months	679	39.8	41.2	39.8	31.0	37.8	42.1	56.5	34.7
48+ months	482	35.5	21.2	29.8	43.4	25.0	42.2	58.6	37.9
χ2 value		22.877***	12.682**	3.210	15.270**	NA	10.873*	2.163	2.928
Size of child at birth									
Very small	118	48.3	21.1	48.1	37.5	66.7	58.6	70.0	54.5
Small	278	43.5	24.3	33.3	35.3	36.8	58.1	67.7	37.1
Average or larger	1964	33.9	34.3	36.3	29.9	26.8	31.6	50.5	33.3
χ2 value		18.305***	2.711	1.800	NA	NA	23.968***	NA	NA
Breastfeeding status									
No breastfeeding	552	33.5	24.8	34.7	40.9	29.0	33.0	50.0	22.9
Breastfeeding	1811	36.4	35.5	37.1	25.1	28.5	39.3	55.3	37.6
χ2 value		1.590	3.891*	.283	9.728**	.004	1.266	.180	2.786
Residence									
Urban	1252	31.9	28.5	33.7	27.4	28.9	33.9	45.8	36.3
Rural	1111	40.3	37.6	39.0	39.8	29.4	42.6	61.5	35.0
χ2 value		17.713***	3.551	1.924	5.172*	0.007	3.550	3.604	.0339
Mother's education									
Illiterate	815	45.8	45.1	41.6	49.5	45.8	49.6	65.5	41.1
Primary	472	36.8	30.9	36.2	35.7	30.3	41.1	48.1	38.2
Secondary	570	31.6	30.2	33.3	21.4	25.0	39.1	52.9	30.6
SLC and Higher	506	23.6	27.3	11.7	21.6	26.3	19.2	41.9	29.2
χ2 value		72.749***	7.521	20.398***	24.203***	NA	22.263***	5.287	2.464
Wealth index									
Poorest	486	49.3	42.7	62.5	55.2	37.2	38.7	61.9	46.5
Poorer	512	38.0	37.6	42.7	21.3	35.9	41.6	45.5	37.0
Middle	534	35.3	30.1	38.7	16.7	23.3	45.3	33.3	20.7
Richer	512	32.6	28.9	32.5	36.1	22.5	38.8	36.4	20.8
Richest	318	17.6	16.2	14.8	16.1	20.0	22.1	20.0	15.4
χ2 value		88.262***	9.810**	19.618**	42.277***	4.804	9.887*	NA	NA
Total		35.8	32.8	36.5	30.7	28.6	37.0	54.7	35.3
No. of children		2363	377	642	360	182	445	150	205

- *NA refers to those provinces where at least 1 cell has less than 5 expected frequencies.*
- **refers to α <.050, ** refers to α<.010, *** refers to α<.001.*
- *Threshold values of stunting: < 20%: Low prevalence, 20-29%: Medium prevalence, 30-39%: High prevalence, ≥ 40%: Very high prevalence* (WHO, 2010).
- *(NDHS dataset, 2016).*

Table 2: Prevalence of wasting (thin for height below -2 SD) of children under 5 years in different Provinces of Nepal by background characteristic, 2016.

Characteristics	Children Weight/height measured (Nepal)	Prevalence of wasting							
		Nepal	Koshi	Madhesh	Bagmati	Gandaki	Lumbini	Karnali	Sudur Pashchim
Age of child									
0-11	464	16.8	23.8	24.1	10.9	15.8	9.3	13.3	13.2
12-59	1895	8.0	8.6	12.8	2.4	3.5	7.5	5.8	8.4
χ2 value		33.972***	14.396***	9.381**	NA	NA	.342	NA	NA
Sex of child									
Male	1231	9.6	9.0	14.5	4.7	7.3	7.0	8.3	11.7
Female	1128	10.0	15.3	15.3	3.2	4.7	8.5	7.6	6.5
χ2 value		.119	3.640	.075	.543	.528	.332	.028	1.597
Birth order									
1	900	9.5	10.5	15.6	5.8	3.9	8.1	7.5	9.6
2-3	1076	9.2	12.3	13.3	2.4	4.5	7.6	7.5	8.6
4+	384	12.0	14.4	15.9	2.6	7.1	8.1	10.0	12.8
χ2 value		2.736	.663	.845	NA	NA	NA	NA	NA
Birth Interval									
First birth	900	9.5	10.5	15.6	5.8	4.5	8.1	7.5	9.6
0-23 months	303	11.5	9.5	12.7	4.8	25.0	8.3	4.3	17.2
24-47 months	677	9.6	9.4	14.9	2.3	5.4	9.8	10.9	4.1
48+ months	480	9.4	18.8	16.0	2.0	2.3	4.9	6.9	14.3
χ2 value		1.212	4.957	.713	NA	NA	NA	NA	NA
Size of child at birth									
Very small	118	13.4	15.8	21.4	6.2	0.0	10.3	10.0	18.2
Small	276	11.3	2.9	14.6	12.1	5.3	14.7	9.7	11.8
Average or larger	1961	9.4	12.4	14.5	2.9	6.4	6.2	7.3	8.9
χ2 value		2.868	NA	NA	NA	NA	NA	NA	NA
Breastfeeding status									
No breastfeeding	552	6.5	6.9	13.9	2.4	3.2	2.1	5.6	5.7
Breastfeeding	1808	10.8	13.8	15.0	4.7	6.7	9.5	8.3	10.1
χ2 value		8.706**	3.326	.116	NA	NA	5.765*	NA	NA
Residence									
Urban	1251	9.3	9.7	14.9	4.2	8.2	7.6	6.7	12.7
Rural	1109	10.5	14.8	14.9	3.0	3.6	8.2	8.8	6.8
χ2 value		.820	2.325	000	NA	1.724	.051	NA	2.060
Mother's education									
Illiterate	815	12.5	23.8	15.4	1.1	4.3	10.0	8.6	9.6
Primary	470	9.1	9.9	14.7	7.1	3.0	4.5	7.4	11.8
Secondary	569	9.0	9.5	12.9	4.8	7.5	10.4	6.1	10.2
SLC and Higher	505	7.5	7.1	15.0	3.6	8.6	6.1	9.4	8.2
χ2 value		10.466*	13.811**	.335	NA	NA	3.977	NA	.310
Wealth index									
Poorest	483	9.1	9.5	41.2	3.5	7.0	6.7	8.6	11.8
Poorer	513	9.2	8.6	17.4	0.0	0.0	10.1	4.5	5.7
Middle	535	11.0	16.9	9.7	12.9	12.9	7.0	11.1	13.3
Richer	511	11.7	14.4	17.9	2.8	5.1	8.7	10.0	12.5
Richest	318	7.6	8.1	17.0	4.5	10.0	5.8	0.0	0.0
χ2 value		5.170	NA	NA	NA	NA	1.439	NA	NA
Total		9.9	11.9	14.9	3.9	6.6	7.9	8.0	9.8
Number of children		2360	376	643	361	181	444	151	205

- *NA refers to those provinces where at least 1 cell has less than 5 expected frequencies.*
- **refers to α <.050, ** refers to α<.010, *** refers to α<.001.*
- *The threshold value of wasting: <5%: Acceptable, 5-9%: Poor, 10-14%: Serious, ≥ 15%: Critical,* (WHO, 2010)
- *(NDHS dataset. 2016).*

ing but a lower prevalence of wasting in US children while applying the WHO 2006 Growth Standards against the 2000 CDC Growth Charts. On the other hand, there was a higher prevalence of stunting but a lower prevalence of underweight in European children of age 0–12 months while adopting the 2006 WHO Growth Standards against the 2000 CDC Growth Charts [17]. So, valid measurement tools are essential for not only anthropometric measurements but for other measurements as well.

In a study of Chinese children under 5 years of age, the prevalence of stunting, wasting, and being underweight was 14.3, 2.5 and 7.8 percent respectively in 2002 as of WHO standard 1978. Though the status of nutrition has improved in China, the problem still exists in western rural China. The situation of nutrition measurement is far worse in the context of Nepal. Developed country like Japan has a low prevalence of these indices for the past 3 decades [18].

A study in Nigeria supports the finding of this study. This Nigerian research revealed that children of uneducated women and those of women with basic education were more likely to be stunted than those born to mothers with at least secondary education. Similarly, compared to mothers with at least a secondary education, children born to illiterate women were more likely to be underweight [19].

A study in Nepal reveals that stunting in young children in Nepal was linked to various factors such as the child's age, birth order, mother's education and age at first birth, as well as geographic location and wealth quintile. The study recommends taking action to address these determinants as a means of reducing the prevalence of stunting and severe stunting in Nepalese children under five years old. These findings also support the conclusions of this study [20].

A study conducted on Ethiopian children concludes that children who belong to low-income families were more likely to be underweight than those who belong to high-income families [21]. The socioeconomic condition of the people is linked to the nutrition of in general people and the child in particular [22]. These studies have similar findings to this study.

In the study, the stunting and underweight were statistically significant with the size of children at birth in different provinces of Nepal. A study in Pakistan reveals that children who were average or larger size at birth had a lower risk of stunting and underweight than those who were smaller at birth [23]. This evidence has some similarities with this study. The study has some partial similarities to the findings of the Indian study. The multivariate analyses of five regions of India with a high prevalence of stunting, wasting, and underweight, indicate that children below 2 years are more prone to be underweight as well as stunted as compared to children 2-4 years age group. The analyses indicated more likelihood of wasting in male children as compared to female children. Regional variations in wasting were also significant in the study [24].

The findings of the previous research are pertinent to my study as they corroborate the results of my research. Drawing from the evidence provided by these studies, my research endeavours to investigate further details about nutrition at the provincial level.

5 Conclusion

The objective of this article is to assess the prevalence and factors influencing nutrition status, specifically stunting, underweight, and wasting in children under the age of five, using the below -2 standard deviation threshold. The findings indicate that childhood anthropometric measurements are generally poor in Nepal. However, statistical analysis at the provincial level is unreliable due to the small sample size of children in this category. The data suggest that Nepal as a whole suffers from a high incidence of stunting, wasting, and being underweight. Based on the statistical data, it is evident that stunting and underweight are strongly associated with the study variables except gender, whereas wasting is primarily associated with age and the mother's level of education. Children who experience a triple failure of nutrition below the standard threshold are in the worst condition and should be given special attention. The author suggests avenues for future research, calling on upcoming researchers to apply more sophisticated statistical tools and generate more rigorous conclusions by using larger sample sizes for accurate analysis at the provincial level.

Conflict of Interest

Author declares that there is no conflicts of interest related to the research, authorship, and/or publication of this article.

Acknowledgement

I want to express my heartfelt appreciation to everyone who helped me directly or indirectly throughout the process of preparing this article. I would like to extend my sincere thanks to the DHS program for providing the valuable data that was used in this research. The availability of such high-quality and reliable data is crucial in carrying out meaningful research that can potentially inform evidence-based policies and interventions in the field of population and health. Additionally, I am grateful to Dr. Ramesh Babu Kafle and Dr. Komal Prasad Dulal for their invaluable suggestions in preparing this paper.

References

[1] S. Pheasant and C. M. Haslegrave. *Bodyspace: Anthropometry, ergonomics and the design of work*. Taylor & Francis Group, 3 edition, 2018.

[2] K. Casadei and J. Kiel. Anthropometric measurement. In *StatPearls*. StatPearls Publishing, 2022.

[3] K. Cashin and L. Oot. Guide to anthropometry: A practical tool for program planners, managers, and implementers. Technical report, Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360, 2018.

[4] S. Maleta, K.and Virtanen, M. Espo, T. Kulmala, and P. Ashorn. Timing of growth faltering in rural malawi. *Archives of Disease in Childhood*, 88(7):574–578, 2003.

[5] A. Chiabi, P. F. Tchokoteu, V. Takou, F. Fru, and F. Tchouine. Anthropometric measurements of children attending a vaccination clinic in yaounde, cameroon. *African Health Sciences*, 8(3):174–179, 2008.

[6] A Tomkins. Growth monitoring, screening and surveillance in developing countries. In S. J. Ulijaszek and C. G. N. Mascie-Taylor, editors, *Anthropometry: The individual and the population*, pages 108–116. Cambridge University Press, 1994.

[7] S. Nandy and P. Svedberg. *The composite index of anthropometric failure (CIAF): An alternative indicator for malnutrition in young children*. Springer, 2012.

[8] Cape Town Metropole Paediatric Interest Group. Anthropometry guideline: Paediatrics, 2009.

[9] WHO. Nutrition landscape information system (nlis) country profile indicators: Interpretation guide. Technical report, 2010.

[10] S. M. Fishman, L.E. Caulfield, M. de Onis, Monika Blössner, A. A. Hyder, L. Mullany, and R. E. Black. Childhood and maternal underweight. In Majid Ezzati, Alan D. Lopez, Anthony Rodgers, and Christopher J. L. Murray, editors, *Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors*, volume 1, pages 39–162. WHO, 2004.

[11] M. Singh, K. K. Thumburu, N. Jaiswal, and A. Agarwal. Anthropometric measures during infancy and childhood and the risk of developing cardiovascular disease or diabetes mellitus type 2 in later life: A systematic review. *ICMR Advanced Centre for Evidence Based Child Health, PGIMER*, 2015.

[12] T. N. Croft, A. M. J. Marshall, C. K. Allen, F. Arnold, S. Assaf, and S. Balian. *Guide to DHS Statistics*. ICF, 2018.

[13] S. C. Gupta. *Fundamentals of Statistics*. Himalaya Publishing House, 7 edition, 2015.

[14] Nepal Ministry of Health, New Era, and ICF. Nepal demographic and health survey 2016, 2017.

[15] A. M. Kwena, D. J. Terlouw, S. J. De Vlas, P. A. Phillips-Howard, W. A. Hawley, J. F. Friedman, J. M. Vulule, B. L. Nahlen, R. W. Sauerwein, and F. O. T. Kuile. Prevalence and severity of malnutrition in pre-school children in a rural area of western kenya. *The American Society of Tropical Medicine and Hygiene*, 64(Suppl 4):94–99, 2003.

[16] T. Tewabe, M. M. Kamal, K. Alam, A. Quazi, M. Talukder, and S. Z. Hossain. Factors driving underweight, wasting, and stunting among urban school-aged children: Evidence from merawi town, northwest ethiopia. *PLOS Global Public Health*, 3(1):e0000586, 2023.

[17] H. J. Youfa, W .and Chen. Use of percentiles and z-scores in anthropometry. In *Handbook of anthropometry: Physical measures of human form in health and disease (Vol 1)*, pages 28–48. Springer, 2012.

[18] L. Li, H. Li, and H. Ushijima. Anthropometry and the prevalence of child protein-energy malnutrition in china and japan. In Victor R. Preedy, editor, *Handbook of Anthropometry: Physical Measures of Human Form in Health and Disease*, pages 2909–2929. 2012.

[19] S. A. Lawal, D. A. Okunlola, O. A. Adegboye, and I. A. Adedeji. Mother's education and nutritional status as correlates of child stunting, wasting, underweight, and overweight in nigeria: Evidence from 2018 demographic and health survey. *Nutrition and Health*, page 02601060221146320, 2023.

[20] R Tiwari, L. M. Ausman, and K. E. Agho. Determinants of stunting and severe stunting among under-fives: evidence from the 2011 nepal demographic and health survey. *BMC Pediatrics*, 14(239), 2014.

[21] D. Tosheno, Y. M. Adinew, T. Thangavel, and S. Workie. Risk factors of underweight in children aged 6–59 months in ethiopia. *Journal of Nutrition and Metabolism*, 201:1–8, 2017.

[22] R. P. Dhakal. Contribution of social science disciplines to make public health interdisciplinary. *Online International Interdisciplinary Research Journal*, 9(September 2019, Special issue):11–20, 2019.

[23] M. Siddiqa, G.H. Shah, T. L. Mayo-Gamble, and A. Zubair. Determinants of child stunting, wasting, and underweight: Evidence from 2017 to 2018 pakistan demographic and health survey. *Journal of Nutrition and Metabolism*, 2023.

[24] R.K. Sinha, R. Dua, V. Bijalwan, S. Rohatqi, and P. Kumar. Determinants of stunting, wasting, and underweight in five high-burden pockets of four indian states. *Indian Journal of Community Medicine*, 43(4):279–283, 2018.