**Factors Associated with Undernutrition, Anemia and Their Coexistence Among 6-59 Months Children in Nepal: A Secondary Analysis of the Nepal Demographic and Health Survey-2022**

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**Abstract**

**Introduction:** Undernutrition and anemia among children aged 6 to 59 months are significant public health issues in developing countries like Nepal. The co-existence of these conditions impacts growth and childhood development. This study aimed to determine the prevalence of undernutrition, anemia, and their co-existence in Nepal, as well as determine their contributing factors among children aged 6-59 months.

**Methods:** We performed secondary analysis of data from the 2022 Nepal Demographic and Health Survey (NDHS 2022). The outcome variables were undernutrition, anemia, and the co-existence of undernutrition with anemia. Children aged 6-59 months were considered undernourished if they exhibited stunting, wasting, underweight or any combination of these conditions. Anemia was defined as hemoglobin levels <11.0 gm/dL (adjusted for altitude). We applied multivariable multinomial logistic regression to determine factors associated with co-existence, and multivariable logistic regression to assess factors associated with undernutrition and anemia separately. We presented the results from the regression analysis using adjusted odds-ratio (aOR) and 95% confidence intervals (CI).

**Results:** Of the 2395 children, 33.5% had undernutrition and 43.4% had anemia, and 16.0% had undernutrition-anemia. Children from the richest wealth quintile, whose mothers had at least secondary education, and those whose mother participate in household decision-making had 53% (aOR: 0.47; 95%CI: 0.26 to 0.86), 48% (aOR:0.52; 95%CI: 0.32 to 0.93), and 34% (aOR: 0.66; 95%CI: 0.47 to 0.94) lower odds of co-existence of undernutrition and anemia compared to their counterparts. Children with malnourished mothers had 80% (95% CI:1.20 to 2.70) higher odds of co-existence of undernutrition and anemia compared to their counterparts.

**Conclusion:** The prevalence of undernutrition, anemia, and co-existence in children is high. Targeted interventions are essential to reduce these conditions and improve children’s nutritional status.

*Keywords: undernutrition; anemia; co-existence; 6-59-months children; Nepal; NDHS 2022*

**Introduction**

Undernutrition encompassing stunting, wasting, underweight constitutes a major public health challenge among children under 5 years (U-5) of age globally. This issue is particularly pronounced in developing countries like Nepal [1–4]. It results from three different causes – immediate, underlying, and basic. Immediate causes include inadequate diet intake and repeated illnesses. The underlying causes consist of inadequate care from mothers, lack of access to healthcare facilities, poverty, and food insecurity. The basic causes include limited information, political and economic insecurity, gender inequality, and the occurrence of natural disasters [5].

Stunting, wasting, and being underweight are the indicators of poor nutritional status for children. While stunting indicates chronic malnutrition reflecting long-term nutrient deficiencies and is linked with delayed motor development and impaired cognitive development[6], wasting indicates acute malnutrition associated with recent severe food shortages or illnesses leading to weight loss and is a strong predictor of mortality [6]. Underweight combines information about linear growth obstruction and weight for length or height [7].

Anemia, particularly iron deficiency anemia, is another common and pressing public health concern among children U-5 in low-, middle- and high-income countries. It results from poor nutrition and has severe adverse health consequences including impaired cognitive development, impaired immunity, disability, and increased risk of morbidity and mortality[8–10].

In 2022, the global prevalence of stunting among children under five years of age was 22.3%, while in South Asia, it reached 31.8%. Additionally, the global prevalence of wasting was recorded at 6.8%, with South Asia reporting a prevalence of 14.8%.[11]. In 2019, global anemia prevalence was 39.8%, which is equivalent to 269 million children aged 6-59 months [12]. In Nepal, the prevalence of stunting, and wasting among children under 5 was 25% and 8% respectively, and the prevalence of anemia was 43% among children 6-59 months old [13].

The co-existence of undernutrition and anemia increases the risk of childhood morbidity and mortality[14–16]. Almost fifty percent of deaths among children under the age of five are associated with undernutrition, which predominantly occurs in low- and middle-income countries (LMICs). Notably, 88% of these countries (124 out of 141) experience multiple forms of malnutrition [17]. The developmental, economic, social, and medical impacts of the global burden of undernutrition and anemia among children are serious and lasting, for individuals and their families, communities, and countries [7].

Anemia and undernutrition are both concentrated in socioeconomically disadvantaged groups, and they share numerous multifaceted causes involving complex interactions between diet, transmissible illnesses, and other factors, such as inadequate care and unhealthy household environments that adversely affect the cognitive development and physical well-being of children and may lead to increased mortality[18–20]. For instance, lower maternal education levels and socioeconomic status are linked with higher rates of malnutrition among children[18].

Though the concern on nutrition has advanced beyond the existence of a single form of malnutrition to the co-existence of multiple malnutrition[18], most of the studies focused on undernutrition and anemia separately. There are limited studies that explored the co-existence of undernutrition and anemia among U-5 children comprehensively. In addition, there are limited studies exploring factors associated with the co-existence of undernutrition and anemia among U-5 children in Nepal.

This study aims to ascertain the prevalence of stunting, wasting, and underweight, as well as their co-occurrence, and the co-existence of undernutrition and anemia in Nepal. It also assesses the association of undernutrition, anemia, and co-existence of undernutrition with household economic status, maternal education and nutritional status, and exposure to televised or broadcasted health programs among children aged 6-59 months in Nepal. By identifying these factors, this study aims to inform the development of targeted interventions and policies designed to mitigate malnutrition within this vulnerable population, thereby enhancing child health outcomes and alleviating the burden of malnutrition in Nepal.

**Methods**

*Data source*

In this study, we analyzed data from the Nepal Health Demographic Survey (NDHS) conducted in 2022 [21]. NDHS 2022 is the nationally representative survey implemented by New ERA under the aegis of the Ministry of Health and Population (MoHP) with the technical support of ICF International and funding from the United States Agency for International Development (USAID) [13]. This survey was conducted to provide estimates of key demographic and health indicators at the national and provincial levels. This study included 13, 786 households, from which information on 14,845 women aged 15–49 years and 4,913 men aged 15-49 years and 2,643 children under 5 years.

*Ethical approval*

We received permission from the official website of “the DHS program” (<https://www.dhsprogram.com>) to download and use (*submitted on: 07/25/2023 and approved on 07/26/2023* ) NDHS 2022 dataset [21]. NHDS 2022 obtained ethical approval from the institutional review board of ICF International, United States of America (*Reference number: 180657.0.001.NP.DHS.01, Date: 28th April 2022).* and the ethical review board of Nepal Health Research Council (*Reference number: 678, Date: 30th September 2021*) [13]. In the NDHS 2022, informed consent was taken from the participants before enrolling them into the study.

*Study setting*

This study used nationally representative data from Nepal, a landlocked country located in Southeast Asia with an area of 147, 516 km2 [22]. It has seven administrative provinces, within which lies 753 municipalities (6 metropolitan cities, 11 sub-metropolitan cities, 276 urban municipalities, 460 rural municipalities) [22]. Nepal has three ecological belts- Mountain, Hill, and Terai. Based on the 2021 Census, the total population of Nepal was 29,164,578 of which 14,911,027 (51.1 %) were females and 14,253,551 (48.9 %) were males [22]. The human development index (HDI) of rural and urban parts of Nepal were 0.647 and 0.561 respectively with an overall HDI of 0.587 [23].

*Sample and sampling*

The NDHS 2022 used a two-stage stratified cluster sampling of households and stratification was achieved based on rural and urban settings. In the first stage of sampling, Primary Sampling Units (PSUs) were nominated by probability proportional to size followed by a systematic selection of households from individual PSUs during the second stage of sampling. In this study, we will analyze the data of 2,395 children aged 6 months to 5 years using NDHS 2022 dataset.

*Measures*

Outcome variables

The primary outcome was “Coexistence of undernutrition (stunting, wasting or underweight) and anemia”. A child is classified to have undernutrition if they exhibit stunting, wasting, underweight, or any of these conditions.[24] Anemia was assessed using altitude-adjusted hemoglobin levels and a child was considered anemic if the level was less than 11.0 gm/deciliter [13]. The outcome variable co-existence of undernutrition and anemia consists of four categories a) Normal (having neither undernutrition nor anemia) b) only undernutrition (having only undernutrition) c) only anemia (having only anemia) and d) co-existence of undernutrition-anemia (having both undernutrition and anemia).

Children whose height-for-age z-score is below minus two standard deviations (–2 SD) from the median of the reference population were defined as stunted [ 24]. Children whose weight-for-height z-score is below –2 SD from the median of the reference population were defined as wasted [25]. Children whose weight-for-age z-score is below –2 SD from the median of the reference population were defined as underweight[25].

Exposure variables

The exposure variables for this study were wealth quintile (poorest/poorer/middle/richer/richest), maternal body mass index (thin/normal/overweight or obese), mother’s education (no education/ basic level education/Secondary and higher level), mother’s exposure to health programs in television and radio (yes/no), and mother’s participation in household decision making (yes/no). The definition of each exposure variable is explained in table 1 below*:*

**Table 1: List of exposure variables with their definition**

|  |  |
| --- | --- |
| **Variables** | **Definition** |
| Wealth quintile | The wealth quintile measures the economic status of the household, and it is classified into poorest, poorer, middle, richer, and richest based on the wealth index [13]. |
| Maternal body mass index (BMI) | The maternal BMI was classified as thin, normal, overweight, and obese based on the body mass index of the mother. The mother will be considered thin if BMI is less than 18.5 kg/m2, normal if BMI is between 18.5 to 24.9 kg/m2, overweight if her BMI is between 25-29.9 kg/m2, and obese if her BMI is greater than 30.0 kg/m2 [13] |
| Mother’s education | Mother’s education was classified into basic education (grades 1 to 8), secondary level education (grades 9 to 12), or higher education (grades 13 and above) based on the DHS questionnaire [13]. |
| Mother’s exposure to Health program in TV/radio | The women were considered to have exposure to specific health programs if they heard or saw health programs on the radio or television (TV). This is measured based on the DHS questionnaire. These programs included eight different health-related programs broadcasted from radio and TV namely *Jana Swasthya Bahas* (Public Health Debate) television program, *Jeevan Chakra* (Life Cycle) television serial, *Jana Swasthya* (Public Health) radio program, *Swasthya Gatibidhi* (Health Affairs) radio program, *Eak Dui Tin Sunau eekai Chhin* (Listen for a While) radio program, *Bhanchhin Ama* (Mother Says) radio program, *Hello Bhanchin Ama* (Mother Says Hello) radio program and *Jeewan Rakshya* (Save Life COVID- response) radio program [13,26]. |
| Mother’s participation in household decision-making | A composite variable measured from the mother’s participation (alone or with her husband) in making three household decisions (access to healthcare, major household purchases, and visits her family or relatives) grouped into no participation or participation in decision-making [13]. |
| Anemia status in mother | Anemia was assessed using altitude-adjusted hemoglobin levels and a mother was considered anemic if the level was less than 11.0 gm/deciliter. [13] |

Potential Confounding variables

Based on the existing literature, some variables were found to be the potential confounders in the association between outcome and exposure. They were sociodemographic variables consisting of place of residence (rural/urban), and ecological belt (mountain/hill/terai), child-related variables consisting of the age of the child (in months) and sex of the child (male/female), and parents-related variables consisting of parity (Primipara/Multipara) and father’s education (no education/basic level/secondary and higher level).

*Statistical analysis*

We conducted pre-analytical processing and statistical analysis using R version 4.3.2 [27] and R studio [28]. We carried out weighted descriptive and inferential analysis using the “survey” package to address complex survey design and non-response. We presented parametric numerical variables as mean (standard deviation) and non-parametric numerical variables as median (interquartile range) with their 95% confidence interval (CI). We presented categorical variables as frequency, percent, and their 95% CI. We computed the prevalence and 95% CI using the Wilson method.

All regression analyses were conducted using complete cases after excluding observations with missing data. We performed multivariable multinomial logistic regression, to determine the association between the co-existence of stunting, wasting, and anemia (normal/undernutrition only/ anemia only/ co-existence) and predictor variables. We performed binary logistic regression to determine the association between undernutrition or anemia with the predictor variables. We checked for multicollinearity using variance inflation factor (VIF) and removed province (VIF= 13.31, greater than the cutoff of 10) from the regression models. We calculated and presented crude and adjusted odds ratio (aOR) and their 95% CI.

**Results**

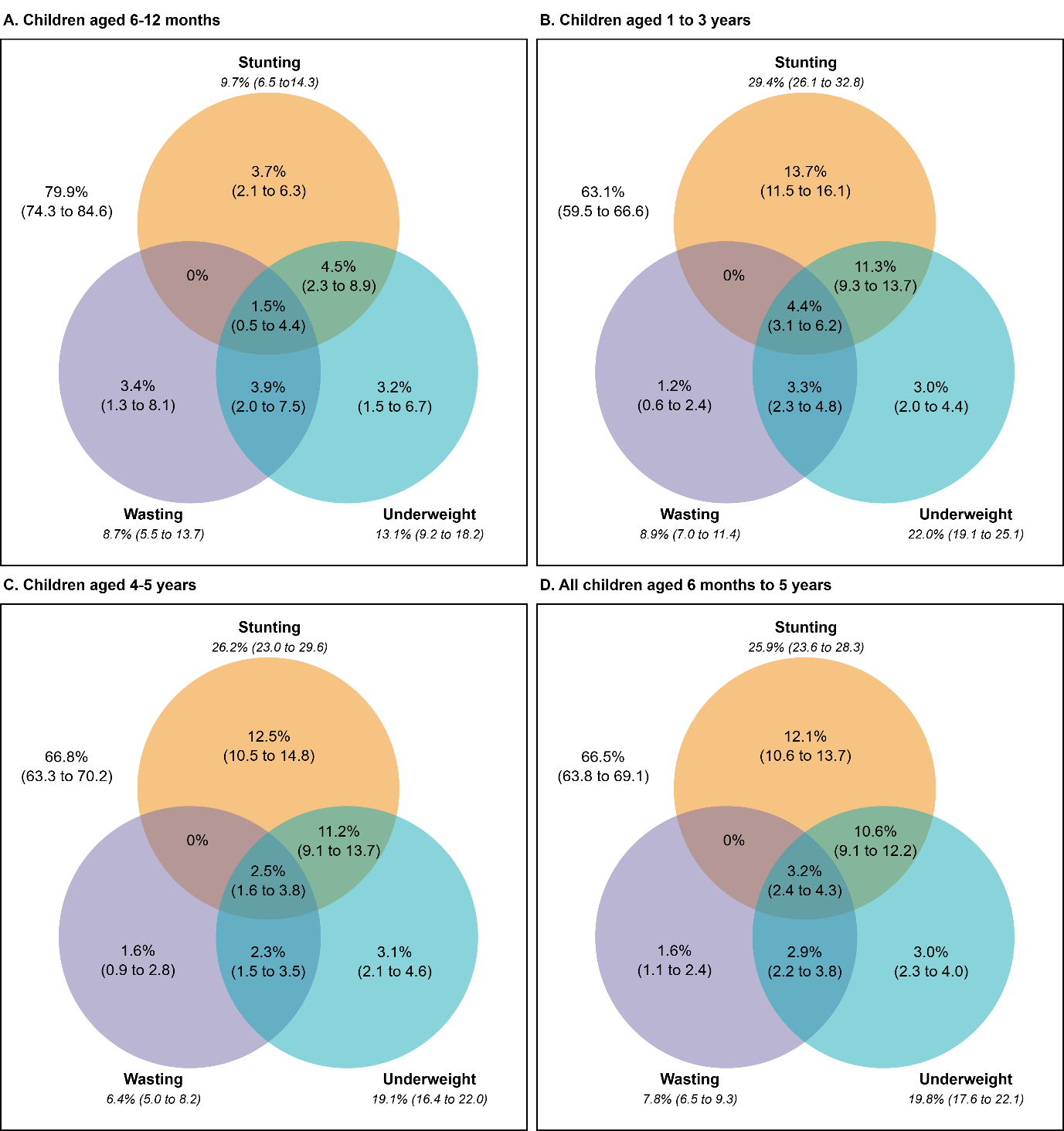
Table 2 presents the sociodemographic characteristics of 6-59 months children stratified by age. Of the total U-5 children, 48.5% were female. Age distribution showed 10.4% were 6-12 months old, 45.8% were 1-3 years old, and 43.8% were 4-5 years old. Most children (59.1%) were from the Terai region, while the fewest (5.6%) were from the mountain region. The ratio of children from urban to rural areas was 2:1. By province, the majority were from Madhesh (26.4%), followed by Koshi (17.9%), Lumbini (16.7%), and Bagmati (15.4%).

**Table 2: *Characteristics of 6-59 months children***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristics** | **Overall**  **n (%)** | **Late infant (6-12 months)**  **n (%)** | **Toddler (1 to 3 years)**  **n (%)** | **Pre-school age (4-5 years)**  **n (%)** |
| *Unweighted N* | 2395 | 256 | 1092 | 1047 |
| *Weighted N* | 2335 | 244 | 1069 | 1022 |
| **Age of children,** n (%) |  | 10.4 | 45.8 | 43.8 |
| **Sex** |  |  |  |  |
| Male | 51.5 | 52.6 | 51.4 | 51.3 |
| Female | 48.5 | 47.4 | 48.6 | 48.7 |
| **Ecological region** |  |  |  |  |
| Mountain | 5.6 | 5.6 | 5.6 | 5.6 |
| Hill | 35.3 | 41.7 | 34.4 | 34.7 |
| Terai | 59.1 | 52.7 | 60 | 59.8 |
| **Type of place of residence** |  |  |  |  |
| Urban | 64.3 | 63.1 | 64.2 | 64.7 |
| Rural | 35.7 | 36.9 | 35.8 | 35.3 |
| **Province** |  |  |  |  |
| Koshi | 17.9 | 18.7 | 17.2 | 18.5 |
| Madhesh | 26.4 | 20.7 | 27.2 | 27 |
| Bagmati | 15.4 | 20 | 15.8 | 13.9 |
| Gandaki | 7.2 | 6.7 | 6.1 | 8.5 |
| Lumbini | 16.7 | 15.6 | 17.1 | 16.6 |
| Karnali | 7.7 | 9.8 | 7.1 | 7.8 |
| Sudurpashchim | 8.6 | 8.5 | 9.6 | 7.7 |
| **Wealth quintile** |  |  |  |  |
| Poorest | 24.5 | 22.2 | 24.4 | 25 |
| Poorer | 22 | 19.9 | 23.5 | 20.9 |
| Middle | 20.7 | 19.6 | 19.6 | 22 |
| Richer | 18.1 | 19.1 | 19.2 | 16.8 |
| Richest | 14.7 | 19.2 | 13.3 | 15.2 |
| **Mother education** |  |  |  |  |
| No education | 22.2 | 15.3 | 23.1 | 22.9 |
| Basic | 35.9 | 32.5 | 35.7 | 37 |
| Secondary and higher | 41.9 | 52.2 | 41.2 | 40 |
| *Missing* | 55 | 0 | 14 | 40 |
| **Father’s education** |  |  |  |  |
| No education | 10.7 | 6.1 | 10.8 | 11.8 |
| Basic | 41 | 42.2 | 41.1 | 40.7 |
| Secondary and higher | 48.3 | 51.7 | 48.1 | 47.6 |
| *Missing* | 322 | 27 | 135 | 160 |
| **Mother’s age at birth** |  |  |  |  |
| <20 | 19.8 | 18.3 | 19.2 | 20.8 |
| 20-34 | 76.3 | 78.9 | 77.7 | 74.2 |
| 35-49 | 3.9 | 2.8 | 3.1 | 5 |
| *Missing* | 259 | 21 | 104 | 134 |
| **Parity** |  |  |  |  |
| Primipara | 32.1 | 41.3 | 37.3 | 24.2 |
| Multipara | 67.9 | 58.7 | 62.7 | 75.8 |
| *Missing* | 259 | 21 | 104 | 134 |
| **Maternal BMI** |  |  |  |  |
| Normal (18.5 to 24.9 kg/m2 ) | 61.7 | 58.1 | 62.2 | 62.1 |
| Overweight or obese (>=25 kg/m2 ) | 23.7 | 29.7 | 20 | 26 |
| Thin (<18.5 kg/m2) | 14.6 | 12.2 | 17.8 | 11.9 |
| *Missing* | 399 | 22 | 185 | 192 |
| **Mother’s participation in household decision making** |  |  |  |  |
| No participation | 33.5 | 32.5 | 34.6 | 32.6 |
| Participation | 66.5 | 67.5 | 65.4 | 67.4 |

*n: weighted frequency; %: weighted percentage*

***Figure 1*** presents the prevalence of stunting, wasting and being underweight among Nepalese children aged 6-59 months. The prevalence of stunting, wasting, and underweight were 25.9% (95% CI: 23.6, 28.3), 7.8% (95% CI: 6.5, 9.3), and 19.8% (95% CI: 17.6, 22.1), respectively. Of the total children, 3.2% (95% CI: 2.5, 4.3) had all three conditions, 13.5% (95% CI: 11.9, 15.3) had two of the three conditions, and 16.8% (95% CI: 15.2, 18.5) had one of the three conditions.



*Figure 1: Prevalence of coexistence of different forms of undernutrition among A) children aged 6-12 months, B) children aged 1-3 years, C) children aged 4-5 years and D) all children aged 6 months to 5 years.*



*Figure 2: Prevalence of anemia among A) children aged 6-11 months, B) children aged 1-3 years, C) children aged 4-5 years and D) all children aged 6 months to 5 years.*

**[Figure 2 here]**

(95% CI:16.8, 20.9) (95%CI: 22.7, 26.6) The prevalence of moderate to severe anemia was highest in late infants, accounting for 39.9% (95% CI: 33.2, 47.1) and decreased to 8.4% (95% CI: 6.7, 10.8) in preschools (***Figure 2***).



*Figure 3: Prevalence of co-existence of anemia with stunting, wasting, underweight, and overall undernutrition*

**[Figure 3 here]**

***3***

**Table 3: *Co-existence of anemia and undernutrition conditions (n=*2,335)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Characteristic** | **Overall,**  **% (95%CI)** | **6-12 months,**  **% (95%CI)** | **1-3 years,**  **% (95%CI)** | **4-5 years,**  **% (95%CI)** |
| **Normal** | 39.1 (36.6, 41.7) | 25.0 (19.4, 31.6) | 33.6 (30.5, 36.9) | 48.2 (44.3, 52.1) |
| Only Anemia | 27.4 (25.3, 29.6) | 54.9 (48.3, 61.3) | 29.5 (26.4, 32.7) | 18.6 (15.8, 21.8) |
| Only undernutrition | 17.5 (15.6, 19.6) | 3.9 (1.99, 7.49) | 14.9 (12.5, 17.6) | 23.5 (20.6, 26.8) |
| Co-existence pf undernutrition and anemia | 16.0 (14.1, 18.0) | 16.2 (11.7, 22.0) | 22 (19.1, 25.3) | 9.6 (7.89, 11.7) |

*%: weighted percent; CI: confidence interval*

Table 4: Distribution of undernutrition, anemia and their coexistence across exposure variables

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristics** | **6-12 months** | | | **1-3 year** | | | **4-5 years** | | |
| **Undernutrition only** | **Anemia only** | **Co-existence** | **Undernutrition** | **Anemia** | **Co-existence** | **Undernutrition** | **Anemia** | **Co-existence** |
| **Wealth quintile** |  |  |  |  |  |  |  |  |  |
| Poorest | 55.9 | 4.3 | 19.0 | 24.2 | 19.7 | 26.6 | 12.3 | 30.9 | 13.2 |
| Poorer | 51.7 | 1.8 | 15.2 | 30.3 | 16.4 | 25.4 | 17.6 | 27.4 | 11.0 |
| Middle | 60.9 | 3.3 | 12.2 | 31.0 | 12.3 | 21.3 | 24.4 | 27.3 | 10.1 |
| Richer | 56.9 | 4.0 | 24.0 | 35.2 | 12.5 | 18.5 | 29.5 | 13.0 | 5.9 |
| Richest | 48.8 | 6.2 | 10.4 | 27.2 | 10.4 | 13.7 | 10.2 | 12.4 | 5.3 |
| **Mother education** |  |  |  |  |  |  |  |  |  |
| No education | 51.7 | 8.1 | 20.9 | 27.5 | 15.1 | 35.5 | 21.9 | 29.0 | 15.6 |
| Basic | 51.1 | 1.1 | 22.4 | 27.7 | 16.1 | 22.9 | 17.7 | 27.9 | 9.4 |
| Secondary and higher | 58.1 | 4.4 | 11.0 | 32.3 | 13.8 | 13.9 | 18.0 | 15.9 | 7.2 |
| **Participation in household decision** | 52.9 | 4.7 | 14.9 | 28.5 | 14.9 | 21.3 | 17.9 | 22.2 | 9.4 |
| **Exposure to health programs in TV/radio** | 64.3 | 4.7 | 11.9 | 24.6 | 15.5 | 14.2 | 16.6 | 26.7 | 10.0 |
| **Maternal BMI** |  |  |  |  |  |  |  |  |  |
| Normal | 58.0 | 2.9 | 17.1 | 30.3 | 14.4 | 21.1 | 15.7 | 26.2 | 10.8 |
| Overweight or obese | 46.1 | 5.0 | 13.9 | 37.7 | 10.2 | 12.9 | 22.1 | 18.8 | 5.5 |
| Thin | 50.3 | 6.9 | 25.3 | 22.1 | 22.5 | 33.4 | 28.3 | 22.5 | 13.2 |

Figure 4 and table 4 presents the distribution of anemia, undernutrition and co-existence across categories of wealth quintile, mother’s education, household decision making and mother’s exposure to health programs on TV and radio. The prevalence of undernutrition and co-existence was highest in poorest wealth quintile and lowest in richest wealth quintile, and highest in children whose mother had no education.

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*Figure 4: Distribution of anemia, overall undernutrition and their co-existence of anemia across exposure variables*

**[Figure 4 here]**

Table 5 presents the factors associated with undernutrition and anemia among children aged 6-59 months. In univariable regression, undernutrition was significantly associated with wealth quintile, mother’s education, age of child, and maternal nutritional status. In multivariable regression, undernutrition was found to be associated with age of child, wealth quintile, mother’s education, and maternal nutrition status after adjusting for confounding variables. The odds of having undernutrition is 1.96 times among 1-3 years child and 1.70 times in the 4-5 years children compared to 6-11 months children. The odds of undernutrition were 44% (aOR: 0.56, 95%CI: 0.34 to 0.92) lower in children from the richer wealth quintile compared to the poorest, 36% (aOR: 0.64, 95%CI: 0.45 to 0.93) lower in the child whose mother has secondary or higher-level education. We didn’t find a significant association between undernutrition and mother participation in household decisions and exposure to health programs on TV/radio.

**Table 5: Factors associated with undernutrition among children aged 6-59 months**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** | **Presence of undernutrition, n (%) \*** | **Unadjusted** | | | **Adjusted#** | | |
| **OR** | **95% CI** | **p-value** | **OR** | **95% CI** | **p-value** |
| **Age of child** |  |  |  |  |  |  |  |
| 6-12 months | 49 (20.1) | Ref |  |  | Ref |  |  |
| 1 year to 3 years | 394 (36.9) | 2.32 | 1.67, 3.22 | <0.001 | 1.96 | 1.33, 2.90 | <0.001 |
| 4 to 5 years | 339 (33.2) | 1.97 | 1.39, 2.81 | <0.001 | 1.7 | 1.12, 2.59 | 0.013 |
| **Wealth quintile** |  |  |  |  |  |  |  |
| Poorest | 246 (43.1) | Ref |  |  | Ref |  |  |
| Poorer | 195 (38.1) | 0.81 | 0.62, 1.06 | 0.122 | 0.93 | 0.67, 1.30 | 0.680 |
| Middle | 162 (33.6) | 0.67 | 0.50, 0.88 | 0.005 | 0.78 | 0.54, 1.13 | 0.194 |
| Richer | 109 (25.7) | 0.46 | 0.32, 0.66 | <0.001 | 0.53 | 0.34, 0.82 | 0.005 |
| Richest | 70 (20.2) | 0.33 | 0.22, 0.50 | <0.001 | 0.56 | 0.34, 0.92 | 0.024 |
| **Mother education** |  |  |  |  |  |  |  |
| No education | 234 (46.3) | Ref |  |  | Ref |  |  |
| Basic | 301 (36.7) | 0.67 | 0.52, 0.88 | 0.003 | 0.87 | 0.65, 1.16 | 0.332 |
| Secondary and higher | 231 (24.2) | 0.37 | 0.28, 0.49 | <0.001 | 0.64 | 0.45, 0.93 | 0.019 |
| **Mother’s Participation in household decision** |  | Ref |  |  | Ref |  |  |
| No participation | 279 (35.7) | 0.86 | 0.70, 1.07 | 0.173 | 0.82 | 0.63, 1.06 | 0.133 |
| Participation | 503 (32.4) |  |  |  |  |  |  |
| **Exposure to health program in TV/radio** |  | Ref |  |  | Ref |  |  |
| No | 615 (34.5) | 0.85 | 0.67, 1.09 | 0.199 | 0.92 | 0.69, 1.24 | 0.595 |
| Yes | 145 (31.0) |  |  |  |  |  |  |
| **Maternal BMI** |  | 0.57 | 0.43, 0.75 | <0.001 | 0.75 | 0.56, 1.01 | 0.057 |
| Normal | 411 (34.5) | 1.66 | 1.23, 2.23 | <0.001 | 1.48 | 1.09, 2.01 | 0.013 |
| Overweight or obese | 106 (23.1) | Ref |  |  | Ref |  |  |
| Thin | 132 (46.6) | 2.32 | 1.67, 3.22 | <0.001 | 1.96 | 1.33, 2.90 | <0.001 |

*n: weighted frequency; %: weighted percent; Ref: reference group; OR: odds ratio; aOR: adjusted odds ratio; CI: confidence interval; \* Row percent*

*# adjusted for age, sex of child, father’s education, parity, place of residence, ecological belt, mother’s age at childbirth, and adjusted for each other*

Table 6 presents the factors associated with anemia among children aged 6-59 months. The factors associated were age of the child, wealth quintile, and anemia status of the mother. The odds of having anemia were 41% (aOR: 0.59, 95%CI: 0.36 to 0.97) lower among richest quintile compared to poorest, 64% (aOR: 0.36, 95%CI: 0.24 to 0.53) lower among child aged 1-3 years and 87% (aOR: 0.13; 95%CI: 0.09 to 0.20) lower among 4-5 years children compared to 6-12 months children after adjusting for other independent variables. The odds of having anemia were 1.63 (95%CI: 1.27 to 2.10) times as many children whose mothers were anemic.

**Table 6: Factors associated with anemia among children aged 6-59 months**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** | **Prevalence of anemia,**  **n (%) \*** | **Unadjusted** | | | **Adjusted#** | | |
| **OR** | **95% CI** | **p-value** | **OR** | **95% CI** | **p-value** |
| **Age of child** |  |  |  |  |  |  |  |
| 6-11 months | 173 (71.1) | Ref |  |  | Ref |  |  |
| 1 year to 3 years | 551 (51.5) | 0.43 | 0.31, 0.60 | <0.001 | 0.36 | 0.24, 0.53 | <0.001 |
| 4 to 5 years | 289 (28.3) | 0.16 | 0.11, 0.23 | <0.001 | 0.13 | 0.09, 0.20 | <0.001 |
| **Wealth quintile** |  |  |  |  |  |  |  |
| Poorest | 239 (41.8) | Ref |  |  | Ref |  |  |
| Poorer | 233 (45.5) | 1.16 | 0.88, 1.53 | 0.291 | 0.88 | 0.63, 1.23 | 0.451 |
| Middle | 222 (46.0) | 1.19 | 0.90, 1.56 | 0.215 | 0.89 | 0.61, 1.30 | 0.531 |
| Richer | 209 (49.2) | 1.35 | 1.02, 1.80 | 0.038 | 1.07 | 0.72, 1.60 | 0.725 |
| Richest | 110 (31.9) | 0.65 | 0.46, 0.93 | 0.02 | 0.59 | 0.36, 0.97 | 0.037 |
| **Mother’s education** |  |  |  |  |  |  |  |
| No education | 265 (52.4) | Ref |  |  | Ref |  |  |
| Basic | 347 (42.4) | 0.67 | 0.52, 0.86 | 0.002 | 0.80 | 0.57, 1.13 | 0.210 |
| Secondary and Higher | 388 (40.6) | 0.62 | 0.48, 0.80 | <0.001 | 0.84 | 0.56, 1.26 | 0.409 |
| **Mother’s Participation in decision making** |  |  |  |  |  |  |  |
| No participation | 365 (46.6) | Ref |  |  | Ref |  |  |
| Participation | 648 (41.7) | 0.82 | 0.65, 1.03 | 0.095 | 0.76 | 0.55, 1.05 | 0.099 |
| **Exposure to health program in TV/radio** |  |  |  |  |  |  |  |
| No | 813 (45.6) | Ref |  |  | Ref |  |  |
| Yes | 179 (38.4) | 0.74 | 0.59, 0.94 | 0.012 | 1 | 0.74, 1.35 | 0.990 |
| **Maternal BMI** |  |  |  |  |  |  |  |
| Normal | 516 (43.2) | Ref |  |  | Ref |  |  |
| Overweight or obese | 189 (41.1) | 0.92 | 0.70, 1.21 | 0.548 | 1.19 | 0.87, 1.63 | 0.286 |
| thin | 149 (52.5) | 1.46 | 1.07, 1.98 | 0.016 | 1.20 | 0.84, 1.71 | 0.319 |
| **Anemia status in mother** |  |  |  |  |  |  |  |
| No | 510 (38.8) | Ref |  |  | Ref |  |  |
| Yes | 406 (54.1) | 1.86 | 1.49, 2.32 | <0.001 | 1.63 | 1.27, 2.10 | <0.001 |

*n: weighted frequency; %: weighted percent*

*\* Row percent*

*Ref: reference group; OR: odds ratio; AOR: adjusted odds ratio; CI: confidence interval*

*# adjusted for age, sex of child, father’s education, parity, place of residence, ecological belt, mother’s age at childbirth and adjusted for each other*

Table 7 presents the factors associated with co-existence of undernutrition and anemia among children aged 6-59 months. The co-existence of undernutrition and anemia is significantly associated with the richest wealth quintile, the mother's education status, the mother’s BMI, and presence of anemia in children. The children from the richest wealth quintile were 53% (aOR: 0.49; 95%CI: 0.26 to 0.86) less likely to have co-existence of undernutrition and anemia than children from the poorest wealth quintile. The children whose mothers had secondary or higher-level education had 48% (aOR: 0.52; 95%CI: 0.32 to 0.93) lower odds of having co-existence compared to children whose mothers had no formal education, whose mother’s participation in decision-making in the family was 34% (aOR: 0.66; 95%CI: 0.47 to 0.94) lower odds of having co-existence after adjusting for confounding variables. The child whose mother was classified as thin (BMI<18 kg/m2) was 1.80 times (95%CI: 1.20 to 2.70) more likely and mother with anemia were 2.43 times more likely to have co-existence compared to a child whose mother had normal nutrition status.

**Table 7: Factors associated with co-occurrence of undernutrition and anemia among children aged 6-59 months**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Exposure variables** | **Anemia only vs Normal** | | | **Undernutrition only vs Normal** | | | **Coexistence vs Normal** | | |
| **aOR#** | **95% CI** | **p-value** | **aOR#** | **95% CI** | **p-value** | **aOR#** | **95% CI** | **p-value** |
| **Age of child (ref: 6-11 months chi)** |  |  |  |  |  |  |  |  |  |
| 1-3 years | 0.37 | 0.25 – 0.54 | <0.001 | 3.02 | 1.32 – 6.91 | 0.009 | 0.68 | 0.42 – 1.11 | 0.123 |
| 45 years | 0.16 | 0.11 – 0.24 | <0.001 | 3.16 | 1.39 – 7.20 | 0.006 | 0.21 | 0.12 – 0.35 | <0.001 |
| **Wealth Quintile** *(ref: Poorest)* |  |  |  |  |  |  |  |  |  |
| Poorer | 0.94 | 0.63 – 1.40 | 0.77 | 0.98 | 0.65 – 1.48 | 0.928 | 0.8 | 0.51 – 1.25 | 0.325 |
| Middle | 0.98 | 0.64 – 1.49 | 0.917 | 0.83 | 0.53 – 1.30 | 0.412 | 0.61 | 0.37 – 1.01 | 0.054 |
| Richer | 1.04 | 0.67 – 1.61 | 0.869 | 0.48 | 0.28 – 0.81 | 0.006 | 0.58 | 0.34 – 0.99 | 0.048 |
| Richest | 0.49 | 0.30 – 0.79 | 0.004 | 0.38 | 0.21 – 0.67 | 0.001 | 0.47 | 0.26 – 0.86 | 0.015 |
| **Mother’s education** *(ref: no education)* |  |  |  |  |  |  |  |  |  |
| Basic | 0.87 | 0.60 – 1.27 | 0.473 | 1.00 | 0.67 – 1.49 | 0.996 | 0.70 | 0.46 – 1.06 | 0.094 |
| Secondary and higher | 1.02 | 0.67 – 1.56 | 0.923 | 0.87 | 0.54 – 1.38 | 0.543 | 0.52 | 0.32 – 0.86 | 0.010 |
| **Participation in HH decision** *(ref: nonparticipation)* | 0.69 | 0.51 – 0.93 | 0.016 | 0.73 | 0.52 – 1.02 | 0.064 | 0.66 | 0.47 – 0.94 | 0.02 |
| **Exposure to health programs in TV/radio** *(ref: No)* | 1.04 | 0.77 – 1.42 | 0.783 | 1.00 | 0.70 – 1.42 | 0.996 | 0.89 | 0.59 – 1.34 | 0.572 |
| **Maternal BMI** *(ref: average weight)* |  |  |  |  |  |  |  |  |  |
| Overweight and obese | 1.30 | 0.97 – 1.74 | 0.076 | 0.89 | 0.63 – 1.28 | 0.539 | 0.88 | 0.59 – 1.32 | 0.529 |
| Thin | 1.17 | 0.80 – 1.71 | 0.426 | 1.44 | 0.96 – 2.16 | 0.075 | 1.8 | 1.20 – 2.70 | 0.005 |
| **Anemia in mother** *(ref: No)* | 1.55 | 1.19 – 2.02 | 0.001 | 1.41 | 1.04 – 1.89 | 0.025 | 2.43 | 1.78 – 3.32 | <0.001 |

***Normal:*** *participants having neither undernutrition nor anemia*

***ref:*** *reference group****; aOR:*** *adjusted odds ratio****; CI:*** *confidence interval*

***Bold*** *represents significance at 95% confidence level*

**#** *adjusted for age, sex of child, father’s education, parity, place of residence, ecological belt, mother’s age at childbirth, and adjusted for each other*

**Discussion:**

This secondary analysis to determine the prevalence and factors associated with undernutrition, anemia and co-existence showed the prevalence of undernutrition and anemia to be 33.5% and 43.4% respectively. The prevalence of coexistence of stunting, wasting, and underweight with anemia were 12.5%, 4.0% and 9.7% respectively with 16.0% co-existence between undernutrition and anemia. Undernutrition demonstrated a significant association with wealth quintile, maternal education, parity, and maternal BMI. Anemia was found to be associated with both the wealth quintile and the anemia status of the mother. The simultaneous occurrence of undernutrition and anemia exhibited significant associations with wealth quintile, maternal education status, maternal involvement in household decision-making, parity, maternal BMI, and the child's anemia status. However, undernutrition, anemia, and their co-occurrence were not found to be associated with maternal exposure to health programs in television and radio.

The prevalence of undernutrition defined as anthropometric failure among 6-59 months children in Nepal was 33.5%, which aligns with the rates observed in other LMICs. For instance, a study in Ethiopia reported a higher prevalence of undernutrition among preschool children (50.8%) and children aged 6-59 months (57.3%)[29]. Our findings indicate that Nepal’s burden, though lower, remains substantial. These differences may reflect variations in economic development, food security, and maternal and child health interventions across countries[30].

The prevalence of anemia among 6-59 months children from our study (43.5%) is higher than the global prevalence (39.8%) but lower than the prevalence in African children (60.2%)[12]. Our study also demonstrates a 9.1 percentage-point reduction in anemia prevalence between 2016 (52.6%) [31] and 2022, indicating progress in addressing this issue. Comparable rates had been observed in neighboring countries. A meta-analysis conducted by Kundu et al in Bangladesh showed a prevalence of 46.8% [32] which was similar to our finding. The latest national family health survey (2019-21) in India reported 67.1% prevalence of anemia [33] which is more than what we found in Nepal. The decline in anemia prevalence in Nepal [21] is encouraging but underscores the need for sustained efforts to address this condition, particularly among vulnerable populations.

A systematic review reported the pooled prevalence of wasting-anemia and stunting-anemia in least-developed countries to be 5.4% and 19.5%, respectively[34]. These rates are higher than our findings from Nepal, which were 4.0% and 12.5%, respectively.

The high prevalence of co-existence of undernutrition and anemia in our study (16%) suggests that affected children are trapped in a vicious cycle of micronutrients. Undernutrition impairs iron absorption and utilization, while anemia exacerbates undernutrition by reducing the body’s ability to effectively utilize nutrients.

The children from the richest wealth quintile had lower odds of having co-existence of anemia and undernutrition compared to the poorest wealth quintile. This wealth-related equity gap in undernutrition among children aged 6-59 is attributed to the economic status of households which affects the capability for food insecurity and health care utilization whenever the child is ill [35–37].

The children from a family in which mothers participate in decision-making and mothers who had secondary or higher education were less likely to have co-existence of anemia and undernutrition and anemia alone compared to normal children. The health and nutrition of the child highly depends on the mother, being the primary caretaker of the child with awareness of the child’s health. The analysis of DHS data from Nepal and India suggests that women’s decision-making authority (maternal autonomy in household decision-making) improves child’s nutrition and reduces child mortality, even after controlling for education and wealth[38].

**Strengths and Limitations**

This study has several strengths. First, it utilized complex survey analysis to address complex survey design and non-response rates. Second, the findings from this study are generalizable to children aged 6-59 months in Nepal and to children of the same age group in demographically and economically similar countries, as it used a nationally representative dataset.

This study is not free from limitations. One of the limitations is due to the missing data we could not utilize some of the important dietary factors like minimum dietary diversity score and birth weight of child. Second, due to the cross-sectional nature of the study, the directionality of association is not possible to determine. Third, the results from this study may not be generalizable to populations outside Nepal. Lastly the wide confidence intervals observed in the associations between children’s nutritional status and anemia suggest limited statistical power, likely due to small sample sizes within some subgroups.

**Conclusion**

The prevalence of undernutrition, anemia, and their co-existence remains high among children aged 6-59 months in Nepal. The co-existence of anemia and undernutrition was less likely among children from richest wealth quintile, those whose mothers attained at least secondary level education, and participated in household decision-making. Conversely, co-existence was more prevalent among children whose mothers had poor maternal nutritional status. It is essential to implement holistic programs and targeted interventions to empower poor families and women from high-risk districts thereby improving the nutritional status of children.

**Data availability**

We used publicly available data from Nepal Demographic and health survey database upon request from the official website of “The DHS program” [21]. The link to database is: <https://dhsprogram.com/data/dataset/Nepal_Standard-DHS_2022.cfm?flag=1>

**Conflict of interest**

The authors declare no conflicts of interest.

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35.

**Legends of tables and figures**

**Tables**

**Table 1: List of exposure variables with their definition**

**Table 2: Characteristics of 6-59 months children**

**Table 3: Co-existence of anemia and undernutrition conditions (n=2,335)**

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**Table 6: Factors associated with anemia among children aged 6-59 months**

**Table 7: Factors associated with co-occurrence of undernutrition and anemia among children aged 6-59 months**

**Figures**

**Figure 1: Prevalence of coexistence of different forms of undernutrition among A) children aged 6-12 months, B) children aged 1-3 years, C) children aged 4-5 years and D) all children aged 6 months to 5 years.**

**Figure 2: Prevalence of anemia among A) children aged 6-11 months, B) children aged 1-3 years, C) children aged 4-5 years and D) all children aged 6 months to 5 years.**

**Figure 3: Prevalence of co-existence of anemia with stunting, wasting, underweight, and overall undernutrition**

**Figure 4: Distribution of anemia, overall undernutrition and their co-existence of anemia across exposure variables**