Planning of Births and Childhood Undernutrition in Nepal: Evidence from a 2016 National Survey

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Abstract

Background

Childhood undernutrition is a significant public health issue in low-and middle-income countries, including Nepal. However, there is limited evidence showing the association between the planning of birth (PoB) and childhood undernutrition (stunting and underweight). We aim to investigate the relationship between PoB and childhood undernutrition in the current study.

Methods

We used the Nepal Demographic Health Survey 2016 data, which is a nationally representative cross-sectional household survey. We used two common anthropometric indicators of childhood undernutrition as the outcome of this study. PoB is the main predictor of interest. Binary logistic regression with sampling weights was used to estimate adjusted odds ratios (OR) and 95% confidence intervals to examine the association between the PoB and childhood undernutrition.

Results

The overall prevalence of stunting was 35.8%, and underweight was 27.1% in under-five children in Nepal. We found a higher rate of stunting (52.7%) and underweight (41.1%) in children with birth order > 3 and < 2 years of interval between birth and subsequent birth (IBBSB). The association between the birth order of children and the prevalence of undernutrition had strong statistical significance ($p < 0.001$). Mother's age at marriage ($p = 0.001$), underweight mother ($p < 0.001$), mother's education ($p < 0.001$), father's education ($p < 0.001$), wealth quintile ($p < 0.001$), no exposure to mass media ($p < 0.001$), children's age ($p < 0.001$), area of residence($p = 0.001$) were significantly associated with childhood undernutrition. The result of the multiple logistic regression showed that children with birth order one and 12–24 months of interval between marriage and first birth (IBMFB) had significantly decreased odds of stunting as compared to those children with birth order one and < 12 months of IBMFB (OR 0.6, 95% CI 0.4–0.9).

Conclusion

The findings of the study demonstrate that PoB has a protective effect on childhood undernutrition. Delaying of childbirth until 12–24 months after marriage was found to be associated with reduced odds of childhood stunting. To mitigate childhood undernutrition, Nepal's government needs to promote delayed childbearing after marriage while focusing on uplifting the household economics status and wide coverage of and utilization of mass media.

Background

Childhood undernutrition is a significant public health issue globally. It is estimated that there is one-third of stunted (178 million), and 112 million underweight children, among under-five children.(1) Childhood undernutrition accounts for more than half of the global deaths in children younger than five years of age.(2, 3) It causes a substantial increase in overall disease burden, particularly in low-and middle-income countries, including Nepal.(2, 3)

The government of Nepal (GoN) has made a clear commitment to addressing undernutrition, including childhood undernutrition in Nepal.(4) Nepal signed the global Scaling Up Nutrition (SUN) movement in 2011, agreed by the World Health Assembly (WHA) in 2012.(5) The SUN movement aimed 40% reduction in the global stunting in under-five children by 2025.(6) Currently, Nepal's annual average rate of reduction (AARR) of stunting is 0.031, but it needs to maintain AARR of 0.043 to achieve the global target of stunting in under-five children.(7) Nepal endorsed a multi-sector approach for nutrition and prioritized on improving child nutrition in its five-year Multi-sector Nutrition Plan (MSNP) 2013–2017.(8) Government of Nepal is committed to the declaration of the United Nation (UN) General Assembly '2016–2025 period as the decade of action on nutrition.'(9) In 2017, Nepal endorsed MSNP 2018–2022 and renewed its commitment to nutrition.(7) Nepal also supported the internationally agreed targets (Sustainable Development Goals 2.2 target) on ending all forms of malnutrition by 2030.(10)(11) Specifically, the SDG 2 targets to reduce the prevalence of undernourishment to 3% and underweight prevalence in under-five children to 5% by 2030.(5) All the national nutritional targets of Nepal are also aligned with global nutrition targets.(4)

Department of health service (DoHS), under the Ministry of Health and Population (MoHP), Nepal, executes several national-level nutrition programs, such as Vitamin A supplementation, growth monitoring, Infant and young child feeding (IYCF), iron supplementation, iodine fortification. Under the common framework of MSNP, the GoN has also initiated the implementation of several large-scale, multi-sector, integrated nutrition projects and programs, with support from its development partners. For example, Nepal started *Suaahara* (Good nutrition) projects, KISAN (Knowledge-based Integrated Sustainable Agriculture in Nepal), and SABAL (Sustainable Action for Resilience and Food Security), which are supported by United States Agency for International Development (USAID); *Sunaulo Hazar din* (Golden 1000 days), which is supported by the World Bank; Maternal and Young Child Nutrition Security Initiative in Asia(2011–2015) and *Poshan ko Lagi Hatemalo* (Partnership for Improved Nutrition) (2016–2019), which are supported by the European Union and the United Nations International Children Emmergency Fund (UNICEF).(4) Such an aggressive implementation of the nutrition-specific program has contributed in a progressive decline in the prevalence of undernutrition in under-five children in Nepal. In 2006, stunting in under-five children in Nepal was 49%, which decreased to 41% in 2011, and 36% in 2016.(12–14) Underweight in under-five children has also reduced from 39% in 2006 to 29% in 2011 and 27% in 2016.(12–14) However, the present prevalence rate of stunting and underweight in under-five children in Nepal is substantial.

Family planning has a positive influence on child health and nutritional outcomes.(15) It allows a couple to plan the timing of their childbirth, the number of delivery, and the spacing of childbirth.(15, 16) Previous studies have shown that shorter birth spacing and frequent childbearing cause adverse effect not only on maternal and child health but also lead to poor nutritional outcomes.(15, 17–19) Childbearing at a younger age also causes poor nourishment of children.(20) Therefore, some international agencies have advocated

empowering women to partake in family planning, which also supports to improve maternal, infant, and young child nutrition.(20) For example, *SUAAHARA* (Good Nutrition) program in Nepal advocates for women empowerment and has integrated family planning as one of the eight essential nutrition actions to promote maternal and child nutrition.(21, 22) The theory of change of MSNP-II 2018–2022 has also accepted family planning and reproductive health services, under the health sector response, to achieve nutritional targets.(7) Although family planning may contribute to better nutrition outcomes in under-five children, it has received little attention.(23) Only a few studies exist which have investigated the relationship between family planning and childhood undernutrition.(15, 20, 23–25) Nepal's national nutrition policy and strategy 2004 and national health policy 2019 are the leading policy documents guiding the nutritional interventions in health sectors. Still, both documents are unaware of the relationship between PoB and nutritional outcomes of children due to the lack of stringent evidence. Therefore, this paper aims to examine the association between the planning of birth (PoB) and undernutrition in under-five children in Nepal.

Methods

2.1 *Data source*

We used data from the Nepal Demographic Health Survey (NDHS) conducted in 2016. NDHS is a nationally representative cross-sectional household survey conducted every five years. For the 2016 NDHS, the survey sample of 12,862 is representative at the national and provincial levels, for ecological zones and development regions, and the urban and rural areas.(14) The 2016 NDHS used the sampling frame from the 2011 National Population and Housing Census (NPHC), which was conducted by the Central Bureau of Statistics (CBS). The details of the sampling procedure are available elsewhere.(14) The survey collected a broad range of socioeconomic, demographic, and health data from all eligible men and women of age group 15–49 by administering six well-structured and standardized questionnaire (the household questionnaire, the woman's questionnaire, the man's questionnaire, the biomarker questionnaire, the fieldworker questionnaire, and the verbal autopsy questionnaire for neonatal death). All questionnaires were first finalized in English and then translated into Nepali, Maithili, and Bhojpuri. ICF institutional board (IRB) reviewed the survey. The survey also received ethical approval from the Nepal Health Research Council (NHRC). All interviewers underwent two weeks of a training course using a standard protocol manual, followed by one week of Computer Assisted Personal Interview (CAPI) training before data collection.(26) Written consent was sought from each participant following the NHRC guidelines. The 2016 NDHS yielded a response rate of 99%.

2.2 *Definition of variables*

We considered two common anthropometric indicators of undernutrition, namely stunting (height-for-age) and underweight (weight-for-age), as the outcome variables for this study. As per the World Health Organization (WHO) criteria, children with less than negative two (<−2) standard deviation (SD) below the mean are considered as stunted and underweight.(27) We used normalized z-scores in the NDHS dataset for height for- age and weight-for-age.

For this study, the main predictor of interest is PoB, which is composed of the intersectional axes of birth order, the interval between marriage and first birth (IBMFB), and the interval between births and subsequent

births (IBBSB). We categorized the birth order into three categories: one, 2–3, and > 3. We grouped IBMFB into < 12 months, 12–24 months, 25–36 months, and more than 36 months for the first order birth. For birth order 2–3 and > 3, we divided IBBSB into ≤ 24 months and > 24 months. In total, we created eight intersectional axes of the planning of births.

2.3 *Selection of study sample*

The survey identified 5060 under-five children, of which 4887 were alive, and 173 were dead. After excluding missing cases whose valid date of birth and valid measurement of both height and weight were not reported, NDHS reported 2421 stunted children and 2428 underweight children. The difference between the sample size of stunting and underweight was due to the difference of flagged/missing cases in height and weight measurements. We dropped 7 cases of weight-for-age, i.e., underweight, to make it consistent with the number of stunted children. We also excluded the child whose biological mother was not interviewed. Thus, our final study sample included 2355 children (both for stunting and underweight) for the analysis.

Figure 1 **about here**

2.4 *Statistical analysis*

We used STATA version 15 to conduct data analyses. Descriptive analysis of the outcome and covariates are shown in the table. We performed a chi-square test to assess the association between the predictors and outcome variables. We conducted a binary logistic regression to examine the association between the planning of birth and childhood undernutrition. We controlled the potential confounding variable in the analysis, such as mother's age at marriage in years (< 15/15–19/20–24/25–40), mother's current age in years (15–19/20–24/ 25–29/30–34/35–49), mother's BMI (normal/underweight/obese), mother's anemia (not anemic/anemic), caste (Brahmin/Chhetri/Terai/Madhesi/Dalit/Newar/Janajatis/Muslim/Other), mother's education (illiterate/primary/secondary/higher), father's education (illiterate/primary/secondary/higher), place of residence (urban/rural), mother's occupation (not working/agriculture/paid jobs), wealth quintile (poorest/poorer/middle/richer/richest), exposure to mass media (not at all/less than once a week/at least once a week), sex of the children (male/female), age of the children in months (0–11/12–23/24–35/36–47/48–59), place of residence (urban/rural), ecological region (mountain/hill/Terai), province (Province1/Province2/Province3 (Bagmati)/Province4 (Gandaki)/Province5/Province6 (Karnali)/Province7 (Sudur Pashchim), and household food security (food secure/mild food insecure/moderate food insecure/ severe food insecure). Adjusted odds ratios (ORs) and 95% CIs were calculated to show the effect and significance of the association. We also investigated the potential interaction of the PoB with maternal nutrition and wealth quintile. We considered a p-value < 0.05 for the significant relationship between the exposure and outcome variables. We presented the weighted figures to adjust for variations in the selection probabilities and interviews among participants. The "Svy" command was also utilized to account for complex survey design and to provide unbiased estimates.

Results

Descriptive results

Table 1 presents the descriptive characteristics of the study population. The frequency distribution table shows the highest percentage of order 2-3 children (45.7%), with 35.1% of them having more than 24 months of the interval between birth and subsequent birth (IBBSB). 64.1% of the mothers were married at the age of 15 to 19 years, with a mean age at marriage of 17.7 years. Approximately two-thirds of the mothers (65.4%) had normal basal metabolic index (BMI), and more than half of the mothers (54.2%) of the children were not anemic. Most mothers who participated in the study were illiterate (34.6%), while 45.3% of the mothers had at least secondary education. Almost half of the mothers (46.2%) lived on agriculture. The share of the male children was slightly higher (52.2%) than female children (47.8%) in the survey. The percentage of children for each age, from one to five years, was nearly around one fifth.

The representation of the study population by area of residence was quite similar (urban-52.6% and rural-47.4%). Newar and Janajatis represented the largest percentage (31.1%) of the study participants, while Muslims/others had the least representation (7.5%) in the present study. The distribution of the study population was nearly uniform, around 21% for all categories of wealth quintile except the richest category, which was as low as 13.2%. Most children represented Province 2 (27.4%), while Province 6 had the least percentage of children who participated in the study. 41% of the household were food secured, while only 10.5% were facing severe food insecurity.

Table 1 about here

Rate of stunting and underweight and planning of birth

The present study found a substantial percentage of children with undernutrition (stunting-35.8% and underweight-27.1%) (Table 2). We observed a relatively higher rate of stunting (52.7%) and underweight (41.1%) in children with birth order >3 and <2 years of IBBSB, followed by birth order 2-3 children and <2 years of IBBSB (stunting-41.5% and underweight-32.3%). The association between the birth order of children and the prevalence of undernutrition was highly significant ($p<0.001$).

Mothers who were in the age group 35-49 at the time of the survey had the highest prevalence of child stunting (42.6%) and showed a significant association ($p<0.001$). Children born to the mothers in the age category of 30-34 years had the highest prevalence of underweight (30.4%) but did not show significant association ($p>0.05$). Mother's age at marriage less than 15 years (stunted-42.4% and underweight-33.4%), underweight women (stunted-44.5% and underweight-42.7%), mother's illiteracy (stunting-45.8% and underweight-36.8%), father's illiteracy (stunting-46.3% and underweight-38.1%), poorest wealth quintile (stunted-49.1% and underweight-33.0%), no exposure to mass media (stunted-50.5% and underweight-39.7%), children's age group 24-35 months (stunted 44.8% and underweight-31.1%), rural residence (stunted-40.2% and underweight-31.0%) were the significant predictors of childhood undernutrition ($p<0.05$) (Table 2).

Table 2 about here

Factors associated with stunting

Multiple logistic regression showed that children with birth order 1 and 12-24 months of IBMFB had 0.6 times significantly lower odds of being stunted as compared to children with birth order one and < 12 months of

IBMFB (OR 0.6, 95% CI 0.4-0.9, p<0.05) (Table 3). None of the other birth order and birth interval showed a significant association with stunting (Table 3). The current age of the mother in the age group 20-24 years also had significantly lower odds of having stunted children as compared to the current age of the mothers in the age group < 15 years (OR 0.6, 95% CI 0.4-0.9, p<0.05). Obese mothers had decreased odds of child stunting as compared to mothers with normal BMI. The relationship was statistically significant (OR 0.6, 95% CI 0.4-0.9, p<0.05). However, the relationship between underweight mothers and child stunting was not significant. Mothers with paid jobs had significantly higher odds of stunted children as compared to the mothers who were not working (OR 1.7, 95% CI 1.2-2.4, p<0.01). All categories of wealth quintile (poorer, middle, richer, and richest) had significantly lower odds of child stunting as compared to those who were in the poorest quintile. The corresponding ORs were 0.7 (95%CI 0.5-0.9, p<0.05), 0.6 (95% CI 0.4-0.8, p<0.01), 0.5 (95% CI 0.3-0.8, p<0.01), and 0.3 (95% CI 0.2-0.6, p<0.001) respectively. Exposure to mass media also had significantly decreased odds of stunting as compared to those who did not have exposure at all. The odds ratio was 0.6 for those who were exposed less than once a week (95%CI 0.5-0.9, p<0.01). For those who were exposed at least once a week, the odds ratio was again 0.6 (95% CI 0.5-0.8, p<0.001). We observed highly significant greater odds of stunting in all age categories of the children as compared to the 0-11 months age category. The ORs were 3.2 (95% CI 2.2-4.6, p<0.001), 4.8 (95%CI 3.3-7.1, p<0.001), 3.7 (95% CI 2.4-5.6, p<0.001), and 3.8 (95% CI 2.5-5.8, p<0.001) for age category 12-23 months, 24-35 months, 36-47 months, and 48-59 months respectively. At the administrative level, Province 6 had greater odds of stunting as compared to Province 1 (OR 1.8, 95% CI 1.1-2.7, p<0.01).

Table 3 about here

Factors associated with underweight

Table 4 presents the results of the logistic regression analysis for the odds of underweight in under-five children. Any category of planning of birth did not show a statistically significant relationship with underweight as compared to first-order birth and less than 12 months of IBMFB. Underweight mothers were 1.7 times more likely to have underweight children as compared to mothers with normal BMI (OR 1.7, 95% CI 1.3-2.2, p<0.001). In contrast, obese mothers had significantly lower odds of underweight children as compared to mothers with normal BMI (OR 0.4, 95% CI 0.3-0.7, p<0.001). Poorer, richer, and richest category of wealth quintile showed significantly lower odds of underweight children as compared to those in the poorest quintile. The corresponding ORs were 0.6 (95% CI 0.4-0.9, p<0.05), 0.5 (95% CI 0.3-0.8, p<0.01), and 0.4 (0.2-0.8, p<0.01) respectively. We also observed significantly higher odds of underweight children in the age group 12-23 months (OR 1.6, 95% CI 1.2-2.2, p<0.01), 24-35 months (OR 1.9, 95% CI 1.3-2.7, p<0.001), and 48-59 months (OR 1.9, 95% CI 1.3-2.7, p<0.01) as compared to children in 0-11 months category. At ecological division, the Terai region had 1.8 times higher odds of underweight children as compared to the mountain region. The relationship was statistically significant (OR 1.8, 95% CI 1.1-3.0, p<0.05).

Table 4 about here

Interaction of PoB with maternal nutrition and wealth quintile

We tested for the interaction effect of PoB with maternal anemia for both stunting and underweight separately (not shown in the table). We also examined the interaction between PoB and household wealth quintile. We did not observe any significant interaction.

Discussion

In the present study, we found that the rate of stunting and underweight in under-five children increased significantly with an increase in birth order and shorter birth interval. However, the overall result of multivariate logistic regression did not specifically show a significant relationship between the planning of birth and undernutrition. We found that younger age at marriage, poor socioeconomic characteristics of the mother, area of residence were significantly associated with childhood undernutrition.

Rate of stunting and underweight and planning of birth

The present study found 35.8% stunting and 27.1% underweight in underfive children in Nepal. The national stunting rate and underweight rate in under-five children of selected South Asian countries are quite similar. Pakistan DHS 2017/18 reported the overall stunting rate of 37.6% and underweight rate of 23%.(28) The stunting rate and underweight rate in Bangladesh were 31% and 22%, respectively, as per Bangladesh DHS 2017/18.(29) In contrast, the prevalence rate of stunting and underweight in under-five children in the Maldives is relatively less in comparison to the prevalence rate in other South Asian countries. Maldives DHS 2016/17 reported an only national prevalence rate of 15.3% stunting and 15% underweight.(30) The continuous decline in the prevalence of childhood undernutrition in Nepal since 2001 can be attributed to the rigorous implementation of the several large-scale nutrition-specific projects and programs led by GoN, with the help of development partners.

This study showed that the prevalence of stunting and underweight increases with higher birth order and shorter birth intervals. Specifically, the stunting rate (52.7%) and underweight rate (41.1%) were observed higher in children with birth order >3 and <2 years of IBBSB than other scenarios of the planning of births. This finding was consistent with previous studies that sought to examine the relationship between the planning of birth and childhood undernutrition. For example, a retrospective analysis of the National Family Health Survey (NFHS) 2015/16 data of India also reported the highest rate of stunting (53.1%) and underweight (48.4%) in children with birth order >3 and <3 years of IBBSB.(15) Rana et al. found a lower risk for stunting (20%; $p < 0.01$) and underweight (14%; $p < 0.05$) in the first birth order with >24 months of IBMFB in their retrospective study that analysed DHS data of selected South Asia countries (Nepal, India, Bangladesh, and Pakistan).(20) A retrospective study analyzing a large scale survey in India to investigate the relationship between birth interval and childhood undernutrition also reported a 28% increase in stunting and 26% increase in underweight for those children born with a birth interval of < 24 months.(25)

Factors associated with stunting and underweight

This study showed significantly lower odds of stunting only in children with birth order one and 12-24 months of IBMFB as compared to those children with birth order one and <12 months of IBMFB (OR 0.6, 95% CI 0.4-0.9, $p<0.05$). However, the present study did not yield a significant relationship between the planning of birth

and underweight. The result of a retrospective study analyzing the 2002-2003 El Salvador NFHS data to examine the relationship between birth spacing and childhood undernutrition also showed significantly higher odds of stunting in birth intervals of <24 months (OR 1.52, 95% CI 1.21-1.92) and intervals of 25-35 months (OR 1.30, 95% CI 1.05-1.64) as compared to intervals of 36-59 months.(23) As in the present study, this study also did not show a significant relationship between birth interval and underweight. The birth interval was reported as a significant predictor of child stunting in a cross-sectional study that aimed to measure the prevalence and identify the predictors of undernutrition in children age 0-59 months in Hyderabad, India by Peter et al. (OR 1.82, 95% CI 1.03-3.21).(31)

The result of the multivariate logistic regression showed that low BMI was not the significantly associated with stunting in the present study, but it had significantly higher odds of underweight children as compared to mothers with normal BMI (OR 1.7, 95% CI 1.3-2.2, p<0.001). In contrast, a cross-sectional study examining the factors associated with child stunting and underweight in 35 low-and middle-income countries showed significantly increased odds of child stunting (OR 1.6, 95% CI1.6-1.7, p<0.001) in mothers with low BMI.(32) The significant association was also observed for underweight (OR 2.3, 95% CI 2.1-2.4, p<0.001).(32) Nahar et al., in their case-control study, also reported that severely underweight children were more likely to have underweight mothers (AOR 3.8, 95% CI 2.6-5.4).(33) A cross-sectional study conducted in ten slums of Hyderabad, India, to appraise caregiving practices and health and nutritional status of children under-five reported low BMI of mother to be the significant predictor of stunting (OR 1.99, 95% CI 1.5-4.7).(31) Another retrospective study by Yang et al. reported significantly decreased odds of stunting for obese mothers (OR 0.70, 95% CI 0.61-0.79, p≤0.001), which was consistent to the outcome of the present study (OR 0.6, 95% CI 0.4-0.9, p<0.05).(34)

Mother's current age 20-24 years had a significantly lower odds of stunting as compared to age 15-19 years (OR 0.6, 95% CI 0.4-0.9, p<0.05) in the present study. Another case-control study in Bangladesh that investigated the risk factors associated with severe underweight among young children aged 6-24 months also reported the mother's age <19 years as a strong risk factor to cause child underweight (AOR 3.0, 95% CI 1.9-4.8).(33) In contrast, Yang et al. reported significantly higher odds of stunting in the age group 20-30 (OR 1.18, 95% CI 1.08-1.29, p<0.001).(34)

We obtained significantly lower odds of stunting as well as underweight in poorer, middle, richer, and the richest wealth quintile in comparison to those who were in the poorest wealth quintile (Table 3 and 4). Li et al. also reported that the poorest household wealth was the strongest factor associated with both child stunting (OR 1.7, 95% CI 1.6-1.8, p<0.001) and underweight (OR 1.2, 95% CI 1.1-1.3, p<0.001).(32) A retrospective study analyzing Uganda DHS to examine determinants of stunting in under-five children reported similar higher odds of stunting in the poorest wealth quintile (OR 1.73, 95% CI1.45-2.06, p≤0.001).(34) Another retrospective study analyzing NDHS data also reported higher odds of stunting among babies born to poorer families than those born to wealthier families (AOR 1.51, 95% CI 1.23-1.87).(35)

The present study showed that children > 11 months are a strong predictor of stunting and underweight (Table 3 and 4). A community-based cross-sectional study that examined factors associated with underweight among under-five children in Eastern Nepal reported that children who were > 24 months of age were more likely to be underweight than children <24 months (OR 2.72, 95% CI 1.6-4.7).(36)

To our knowledge, this is one of the few studies in Nepal to examine the relationship between PoB and childhood undernutrition. However, this study has a few known limitations. We used data of the NDHS 2016 cross-sectional survey, but a causal relationship between the associated factors and outcome cannot be inferred from this study. There is a possibility of residual confounding.

Conclusion

The findings of the present study inferred that planning of birth has a protective effect on childhood undernutrition. PoB can increase the length of time between the marriage and first birth, birth intervals between the subsequent births, and can also limit the number of childbirths, thus enabling mothers to have an ample amount of time to recover physically and emotionally. Hence, mothers can improve their health and nutrition, which ultimately contributes to a better nutritional status of children. In a country like Nepal, where 25% of the population lives below the absolute poverty line(37), a focus to uplift the economic status of these populations is quintessential to enable them to practice PoB as a strategy to mitigate childhood undernutrition. The wide geographical coverage and utilization of mass media across the country can also play a crucial role in informing and educating people on PoB and its importance to reduce childhood undernutrition. To sum up, this study provides some statistical evidence, which government authorities, plans and policymakers can use to advocate PoB strategies (integration of nutritional strategies with PoB interventions) to fight against childhood undernutrition. The government of Nepal can use the findings of this study as supportive evidence to formulate and execute evidence-based nutrition-related policies, plans, and programs.

Abbreviations

AARR Annual Average Rate of Reduction

AOR Adjusted Odds Ratio

BMI Basal Metabolic Index

CAPI Computer Assisted Personal Interview

CBS Central Bureau of Statistics

DoHS Department of Health Service

GoN Government of Nepal

IBBSB Interval Between Birth and Subsequent Birth

IBMFB Interval Between Marriage and First Birth

IYCF Infant and Young Children Feeding

KISAN Knowledge-based Integrated Sustainable Agriculture in Nepal

OR Odds Ratio

MoHP Ministry of Health and Population

MSNP Multi-Sector Nutrition Plan

NDHS Nepal Demographic Health Survey

NFHS Nepal Family Health Survey

NHRC Nepal Health Research Council

NPHC Nepal Population and Housing Census

PoB Planning of Birth

SABAL Sustainable Action for Resilience and Food Security

SD Standard Deviation

SUN Scaling Up Nutrition

UN United Nation

UNICEF United Nations International Children Emergency Fund

USAID United States Agency for International Development

WHA World Health Assembly

WHO World Health Organization

Declarations

- Ethics approval and consent to participate

This study includes analysis of the secondary data from the NDHS 2016. So, it was not possible for the authors to identify all the study participants and get written informed consent.

The original survey (NDHS 2016) received informed consent from all the participants in the survey. Written informed consent for participants in the stuy was also obtained where participants were under-five years old children from their parent or guardian.

The NDHS 2016 was reviewed by the ICF institutional review board. Plus, the survey also received ethical approval from the Nepal Health Research Council (NHRC).

- Consent for publication

Not applicable

- Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

- Competing interests

The authors declare that there are no competing interests.

- Funding

Not applicable

- Authors' contributions

IT conceptualized the study, supported analysis, interpreted the data, and drafted the whole manuscript. (Corresponding and Principle author)

KA analyzed the data, supported the drafting of the manuscript, reviewed the manuscript, and provided constructive comments. (Principle author)

YP supported data analysis, reviewed the manuscript, provided constructive comments, and approved the submitted version. (Co-author)

BPS reviewed the manuscript, provided constructive comments, and approved the submitted version. (Co-author)

RK reviewed the manuscript, provided constructive comments, and approved the submitted version. (Co-author)

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Tables

Table 1 Descriptive statistics of the study population

Variables	Percentage	Frequency (n=2355)
Planning of births†		
Order 1 & <12 month of IBMFB	9.2	216
Order 1 & 12-24 months of IBMFB	15.4	362
Order 1 & 25-36 months of IBMFB	7.5	176
Order 1 & >36 months of IBMFB	5.7	134
Order 2-3 & <=24 months of IBBSB	10.6	249
Order 2-3 & >24 months of IBBSB	35.1	825
Order >3 & <=24 months of IBBSB	4.2	100
Order >3 & >24 months of IBBSB	12.2	285
Mother's age at marriage in years		
<15	12.6	297
15-19	64.1	1,509
20-24	19.6	460
25-40	3.7	87
Mean age (sd)=17.7 (3.3)		
Mother's current age in years		
15-19	8.3	195
20-24	34.2	804
25-29	32.6	767
30-34	15.7	369
35-49	9.3	220
Mean age (sd)=26.3 (5.7)		
Mother's BMI†		
Normal	19.2	450
Underweight	65.4	1,537
Obese	15.5	364

Mother's anemia†		
Not anemic	54.2	1,269
Anemic	45.8	1,071
Caste		
Brahmin/Chettri	26.8	632
Terai/Madhesi other	20.2	476
Dalit	14.4	339
Newar/Janajatis	31.1	732
Muslim/other	7.5	176
Mother's education		
Illiterate	34.6	815
Primary	20	472
Secondary	31.8	749
Higher	13.5	319
Father's education†		
Illiterate	15.5	361
Primary	22.9	534
Secondary	44.2	1,033
Higher	17.5	408
Mother's occupation		
Not working	39.7	935
Agriculture	46.2	1,089
Paid jobs	14.1	331
Wealth quintile		
Poorest	20.6	486

Poorer	21.8	513
Middle	22.7	535
Richer	21.6	510
Richest	13.2	311
Exposure to mass media (newspaper/radio/television)		
Not at all	23.1	545
Less than once a week	47.5	1,118
At least once a week	29.4	692
Sex of the children		
Male	52.3	1,231
Female	47.7	1,124
Age of the children		
0-11 months	19.8	465
12-23 months	21.6	508
24-35 months	18.9	446
36-47 months	20.2	476
48-59 months	19.5	460
Mean age(sd)=29.4 (17.2)		
Place of residence		
Urban	52.6	1,239
Rural	47.4	1,117
Ecological region		
Mountain	7.0	164
Hill	36.6	861
Terai	56.5	1,330

Province		
Province 1	16.1	379
Province 2	27.4	645
Province 3	14.8	349
Province 4	7.7	182
Province 5	18.9	445
Province 6	6.4	151
Province 7	8.6	204
Household food security		
Food secure	41	965
Mild food insecure	22.7	535
Moderate food insecure	25.8	609
Severe food insecure	10.5	247

†number of cases missed from the variable:

Planning of birth- 8

Mother's BMI- 4

Mother's anemia- 15

Father's education- 19

Table 2 Rate of stunting and underweight by predictors of this study

Variables	Stunting (%)	95% CI	p-value	Underweight (%)	95% CI	p-value
Total	**35.8**	**33.4,38.3**		**27.1**	**24.7,29.7**	
Planning of births						
Order 1 & <12 month of IBMFB	36.7	29.6,44.5	p=0.000	19.1	13.7,25.9	p=0.000
Order 1 & 12-24 months of IBMFB	28.6	24.0,33.6		24.6	20.0,29.9	
Order 1 & 25-36 months of IBMFB	30.7	23.3,39.3		23.5	16.2,32.8	
Order 1 & >36 months of IBMFB	25.0	18.2,33.3		16.9	10.9,25.3	
Order 2-3 & <=24 months of IBBSB	41.5	35.2,48.2		32.3	26.2,39.0	
Order 2-3 & >24 months of IBBSB	34.1	30.5,38.0		24.7	21.2,28.5	
Order >3 & <=24 months of IBBSB	52.7	41.5,63.5		41.1	30.9,52.1	
Order >3 & >24 months of IBBSB	46.8	40.0,53.6		40.4	33.2,47.9	
Mother's age at marriage in years						
<15	42.4	36.4,48.6	p=0.001	33.4	27.7,39.7	p=0.009
15-19	37.5	34.5,40.5		28	25.4,30.7	
20-24	27.0	23.1,31.2		21.4	17.0,26.5	
25-40	32.4	20.3,47.5		21.2	12.3,34.1	
Mother's current age in years						
15-19	37.8	29.6,46.8	P=0.022	25.6	19.3,33.3	p=0.052
20-24	31.6	28.1,35.2		22.9	19.8,26.2	
25-29	34.9	30.4,39.7		29.5	25.2,34.1	
30-34	42.1	36.2,48.2		30.4	25.2,36.2	
35-49	42.6	34.8,50.7		30.3	23.4,38.3	

Mother's BMI						
Normal	36.2	33.5,38.9	p=0.000	26.4	23.6,29.4	p=0.000
Underweight	44.5	38.6,50.5		42.7	36.8,48.9	
Obese	23.8	18.8,29.7		10.7	7.6,14.9	
Mother's anemia						
Not anemic	35.7	32.4,39.0	p=0.927	24.9	21.9,28.0	p=0.017
Anemic	35.9	32.6,39.3		29.7	26.5,33.1	
Caste						
Brahmin/Chettri	34.7	31.1,38.6	p=0.044	24.1	21.0,27.5	p=0.000
Terai/Madhesi other	41.9	36.3,47.6		37.1	32.2,42.4	
Dalit	39.1	32.6,46.0		30.8	24.5,37.8	
Newar/Janajatis	31.7	27.2,36.5		20.0	16.0,24.6	
Muslim/other	34.7	27.2,43.0		33.8	21.8,48.4	
Mother's education						
Illiterate	45.8	41.9,49.8	p=0.000	36.8	32.5,41.3	p=0.000
Primary	36.7	32.2,41.5		27.9	23.7,32.5	
Secondary	30.2	26.9,33.7		21.4	18.2,24.9	
Higher	22.4	17.6,28.1		14.8	11.0,19.7	
Father's education						
Illiterate	46.3	39.9,52.8	p=0.000	38.1	32.3,44.3	p=0.000
Primary	40.3	35.6,45.2		30.2	25.3,35.7	
Secondary	33.9	30.7,37.3		24.8	21.8,28.0	
Higher	25.3	20.6,30.7		19.6	15.4,24.7	
Mother's education						
Not working	30.0	26.5,33.8	p=0.000	24.9	21.2,29.0	p=0.054
Agriculture	40.6	37.2,44.0		30.2	26.9,33.6	

Paid jobs	36.8	30.5,43.5		23.3	17.9,29.8	
Wealth quintile						
Poorest	49.1	44.2,54.1	p=0.000	33.0	28.2,38.3	p=0.000
Poorer	38.3	33.6,43.2		27.8	23.3,32.8	
Middle	35.4	30.3,40.9		32.8	27.4,38.5	
Richer	32.4	27.6,37.5		23.6	19.2,28.6	
Richest	17.6	13.2,23.0		12.9	8.7,18.7	
Exposure to mass media (newspaper/radio/television)						
Not at all	50.5	45.7,55.3	p=0.000	39.7	34.0,45.7	p=0.000
Less than once a week	32.1	28.9,35.4		22.9	20.1,26.1	
At least once a week	30.4	27.0,33.9		24.0	20.5,27.9	
Sex of the children						
Male	35.9	32.8,39.1	p=0.953	27.0	24.2,30.0	p=0.921
Female	35.8	32.4,39.3		27.2	24.0,30.8	
Age of the children						
0-11 months	16.4	12.7,20.8	p=0.000	18.5	14.8,23.0	P=0.001
12-23 months	37.7	32.7,43.0		28.9	24.2,34.1	
24-35 months	44.8	40.0,49.7		31.1	26.5,36.0	
36-47 months	39.8	35.0,44.8		26.5	22.3,31.2	
48-59 months	40.8	35.3,46.4		30.7	25.8,36.1	
Place of residence						
Urban	31.9	28.7,35.3		23.6	20.7,26.9	p=0.005
Rural	40.2	36.6,44.0	p=0.001	31.0	27.1,35.1	
Ecological region						

Mountain	46.8	38.8,54.9		28.2	21.2,36.6	p=0.000
Hill	32.7	29.1,36.6	p=0.011	18.8	15.9,22.0	
Terai	36.5	33.2,40.0		32.4	29.0,36.0	
Province						
Province 1	32.7	27.1,38.8	p=0.001	24.4	18.4,31.5	p=0.000
Province 2	36.6	32.8,40.6		36.6	31.6,42.0	
Province 3	30.7	23.9,38.5		14.5	9.2,22.1	
Province 4	29.0	22.1,37.0		15.4	10.6,22.0	
Province 5	38.0	31.0,45.5		27.2	21.9,33.3	
Province 6	54.9	48.6,61.1		36.4	30.8,42.4	
Province 7	35.4	29.4,42.0		27.2	22.8,32.1	
Household food security						
Food secure	29.7	26.2,33.5	p=0.000	22.4	19.1,26.2	p=0.003
Mild food insecure	35.7	31.4,40.2		27.4	23.4,31.9	
Moderate food insecure	41.4	36.7,46.2		31.1	26.9,35.6	
Severe food insecure	46.4	38.3,54.7		34.9	26.5,44.4	

Table 3 Results from logistic regression analysis for likelihood of stunting in under-five children

Variables	Adjusted Odds ratio	95% CI
Order 1 & <12 month of IBMFB	ref.	
Order 1 & 12-24 months of IBMFB	0.6*	0.4 – 0.9
Order 1 & 25-36 months of IBMFB	0.7	0.4 - 1.2
Order 1 & >36 months of IBMFB	0.6	0.3 - 1.0
Order 2-3 & <=24 months of IBBSB	0.9	0.6 - 1.4
Order 2-3 & >24 months of IBBSB	0.8	0.5 - 1.1
Order >3 & <=24 months of IBBSB	1.3	0.6 - 2.5
Order >3 & >24 months of IBBSB	0.9	0.5 - 1.6
Mother's age at marriage in years		
<15	ref.	
15-19	1.1	0.8 - 1.4
20-24	0.8	0.5 - 1.3
25-40	1.3	0.6 - 2.8
Mother's current age in years		
15-19	ref.	
20-24	0.6*	0.4 - 0.9
25-29	0.6	0.4 - 1.1
30-34	0.8	0.4 - 1.6
35-49	0.6	0.3 - 1.3
Mother's BMI		
Normal	ref.	
Underweight	1.3	1.0 - 1.7
Obese	0.6*	0.4 - 0.9
Mother's anemia		
Not anemic	ref.	

Anemic	1.0	0.8 - 1.3
Caste		
Brahmin/Chettri	ref.	
Terai/Madhesi other	1.3	0.8 - 2.1
Dalit	1.0	0.6 - 1.5
Newar/Janajatis	0.9	0.6 - 1.2
Muslim/other	0.9	0.6 - 1.5
Mother's education	ref.	
Illiterate	0.8	0.6 - 1.1
Primary	0.9	0.7 - 1.3
Secondary	0.9	0.5 - 1.4
Higher	0.8	0.6 - 1.1
Father's education		
Illiterate	ref.	
Primary	1.0	0.7 - 1.5
Secondary	1.0	0.7 - 1.4
Higher	0.9	0.6 - 1.6
Mother's occupation		
Not working	ref.	
Agriculture	1.1	0.9 - 1.4
Paid jobs	1.7**	1.2 - 2.4
Wealth quintile		
Poorest	ref.	
Poorer	0.7*	0.5 - 0.9
Middle	0.6**	0.4 - 0.8
Richer	0.5**	0.3 - 0.8

Richest	0.3***	0.2 - 0.6
Exposure to mass media (newspaper/radio/television)		
Not at all	ref.	
Less than once a week	0.6**	0.5 - 0.9
At least once a week	0.6***	0.5 - 0.8
Sex of the children		
Male	ref.	
Female	0.9	0.7 - 1.1
Age of the children		
0-11 months	ref.	
12-23 months	3.2***	2.2 - 4.6
24-35 months	4.8***	3.3 - 7.1
36-47 months	3.7***	2.4 - 5.6
48-59 months	3.8***	2.5 - 5.8
Place of residence		
Urban	ref.	
Rural	1.1	0.9 - 1.4
Ecological region		
Mountain	ref.	
Hill	0.8	0.5 - 1.2
Terai	1.1	0.7 - 1.8
Province		
Province 1	ref.	
Province 2	0.7	0.4 - 1.0

Province 3	1.1	0.7 - 1.6
Province 4	1.1	0.7 - 1.8
Province 5	1.1	0.7 - 1.6
Province 6	1.8**	1.1 - 2.7
Province 7	0.8	0.5 - 1.2
Household food security		
Food secure	ref.	
Mild food insecure	1.0	0.7 - 1.3
Moderate food insecure	1.1	0.8 - 1.5
Severe food insecure	1.2	0.8 - 1.8

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

Table 4 Results from logistic regression analysis for likelihood of underweight in under-five children

Variables	Odds ratio	95% CI
Order 1 & <12 month of IBMFB	ref.	
Order 1 & 12-24 months of IBMFB	1.3	0.8 - 2.1
Order 1 & 25-36 months of IBMFB	1.2	0.6 - 2.2
Order 1 & >36 months of IBMFB	0.9	0.5 - 1.7
Order 2-3 & <=24 months of IBBSB	1.2	0.7 - 2.1
Order 2-3 & >24 months of IBBSB	1.1	0.7 - 1.7
Order >3 & <=24 months of IBBSB	1.4	0.7 - 2.7
Mother's age at marriage in years		
<15	ref.	
15-19	0.9	0.7 - 1.3
20-24	0.9	0.6 - 1.6
25+	1.4	0.6 - 3.4
Mother's current age in years		
15-19	ref.	
20-24	1.0	0.6 - 1.5
25-29	1.3	0.8 - 2.3
30-34	1.4	0.8 - 2.6
35+	1.2	0.6 - 2.5
Mother's BMI		
Normal	ref.	
Underweight	1.7***	1.3 - 2.2
Obese	0.4***	0.3 - 0.7
Mother's anemia		
Not anemic	ref.	
Anemic	1.0	0.8 - 1.2

Caste		
Brahmin/Chettri	ref.	
Terai/Madhesi other	1.0	0.7 - 1.6
Dalit	1.0	0.6 - 1.4
Newar/Janajatis	0.8	0.5 - 1.1
Muslim/other	0.8	0.4 - 1.5
Mother's education		
Illiterate	ref.	
Primary	0.9	0.6 - 1.2
Secondary	1.0	0.7 - 1.4
Higher	0.7	0.4 - 1.2
	0.9	0.6 - 1.2
Father's education		
Illiterate	ref.	
Primary	1.0	0.7 - 1.5
Secondary	1.0	0.7 - 1.4
Higher	1.0	0.6 - 1.7
Mother's education		
Not working	ref.	
Agriculture	1.2	0.9 - 1.6
Paid jobs	1.3	0.9 - 2.0
Wealth quintile		
Poorest	ref.	
Poorer	0.6*	0.4 - 0.9
Middle	0.7	0.4 - 1.1
Richer	0.5**	0.3 - 0.8
Richest	0.4**	0.2 - 0.8

Exposure to mass media (newspaper/radio/television)		
Not at all	ref.	
Less than once a week	0.8	0.5 - 1.0
At least once a week	0.7	0.5 - 1.0
Sex of the children		
Male	ref.	
Female	1.0	0.8 - 1.2
Age of the children		
0-11 months	ref.	
12-23 months	1.6**	1.2 - 2.2
24-35 months	1.9***	1.3 - 2.7
36-47 months	1.4	0.9 - 2.0
48-59 months	1.9**	1.3 - 2.7
Place of residence		
Urban	ref.	
Rural	1.1	0.9 - 1.5
Ecological region		
Mountain	ref.	
Hill	0.9	0.6 - 1.4
Terai	1.8*	1.1 - 3.0
Province		
Province 1	ref.	
Province 2	1.0	0.6 - 1.7
Province 3	0.7	0.5 - 1.2

Province 4	0.8	0.5 - 1.4
Province 5	1.0	0.6 - 1.5
Province 6	1.5	0.9 - 2.3
Province 7	0.9	0.6 - 1.3
Household food security		
Food secure	ref.	
Mild food insecure	0.9	0.6 - 1.2
Moderate food insecure	1.0	0.7 - 1.4
Severe food insecure	1.2	0.7 - 1.8

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

Figures

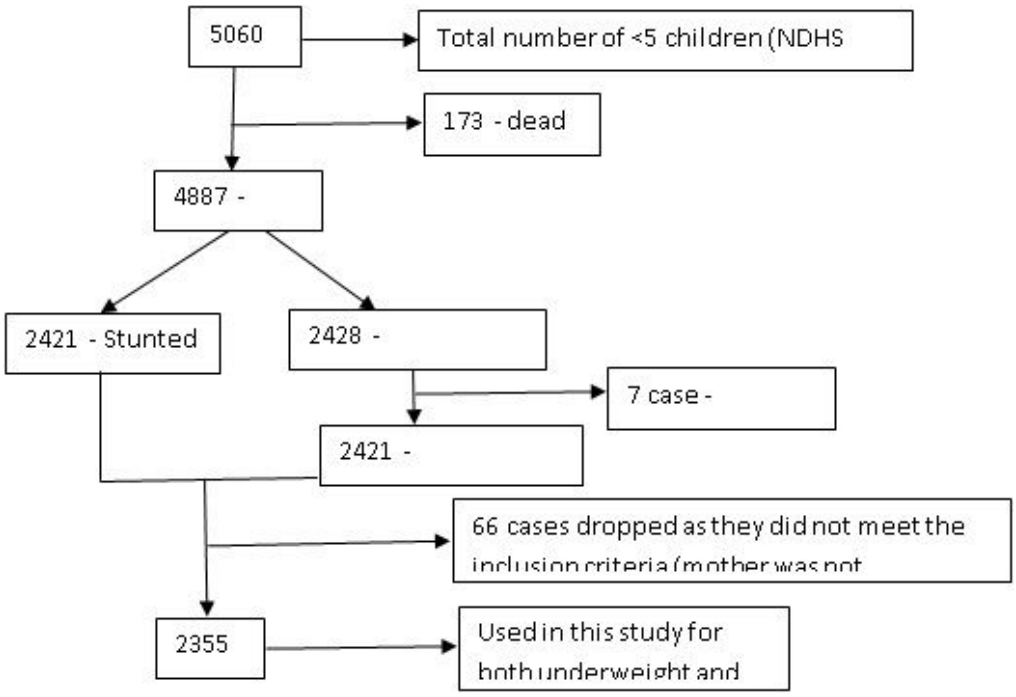

Figure 1

Flowchart of the study sample