RJNMSR
Review Journal of Neurological & Medical Sciences Review

Volume 4, Issue 3, 2026

# SOCIOECONOMIC, MATERNAL, AND CHILD-LEVEL DETERMINANTS OF UNDERNUTRITION AMONG CHILDREN UNDER FIVE YEARS IN SELECTED DISTRICTS OF PUNJAB, PAKISTAN: A CROSS-SECTIONAL STUDY

**Areej Iqbal Awan[1], Hafiz Muhammad Awais Qurani[2], Qaisar Abbas[3], Azain Ahmad Khan[4], Maria Aziz[*5], Sobia Aziz[6], Muhammad Nawaz[7]**

[1]*School of Nursing and Healthcare, BPP University, London*
[2,3]*Nishtar Medical University, Multan, Pakistan*
[4,7]*Department of Pathobiology and Biomedical Sciences, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan*
[*5]*Department of Chemistry, Government College University, Lahore, Pakistan*
[6]*Department of Chemistry, Bahauddin Zakariya University, Multan, Pakistan.*

[*5]azizmaria153@gmail.com

**Corresponding Author: ***
**Maria Aziz**
**DOI:** https://doi.org/10.5281/zenodo.18886686

| Received | Accepted | Published |
|---|---|---|
| 06 January 2026 | 19 February 2026 | 06 March 2026 |

## ABSTRACT

***Background:*** *The problem of child under nutrition has been one of the most significant problems in the context of low and middle income countries such as Pakistan. Punjab, the largest Pakistani province has severe socioeconomic and regional inequalities, which affect nutritional outcomes of children. This paper was to investigate the socioeconomic, maternal, child-related, and environmental factors of stunting, underweight and wasting in children under the age of five years in sample districts in Punjab.*

***Methods:*** *A cross-sectional study involving analysis was done on 3,200 children aged 059 months who were living in Lahore, Faisalabad, Multan, Bahawalpur and Rawalpindi. The data were gathered with the help of household-based survey based on the use of standardized questionnaires and anthropometric measurements. The definition of stunting, underweight and wasting was based on the World Health Organization growth standards. The independent determinants of each nutritional outcome were identified by multivariable logistic regression models and adjusted odds ratios with 95 per cent confidence intervals were presented.*

***Findings:*** *Stunting, underweight and wasting were found to occur at 29.6, 23.1 and 8.9 percent, respectively. The best predictors of stunting and underweight were household poverty and low maternal education. The all kinds of undernutrition were significantly correlated with small birth size and short intervals of birth. In terms of age, exclusive breastfeeding deficiency analysis indicated that it was a major factor in underweight in infants, but scanty dietary diversity played a bigger role in older children. Wasting was mainly correlated with such acute factors as recent illness, unclean drinking water, incomplete immunization, and absence of skilled birth attendance.*

***Implications:*** *The complex of socioeconomic deprivation, maternal features, early-life influences, and environment conditions contribute to child undernutrition in Punjab, which points to the necessity of interventions based on age and complexity of causes.*

**Keywords:** *Child undernutrition; Stunting; Wasting; Maternal education; Socioeconomic status; Punjab Pakistan.*

## INTRODUCTION

Child undernutrition is one of the chronic issues in the world especially in the low- and middle-income countries (LMICs). Early childhood undernutrition affects physical development, intellectual growth, immune system and economic production in the long run, thus continuing poverty and ill health across generations (Morales et al., 2023). Although the world has made significant strides in the last few decades, 148 million children under five years were stunted, 45 million were wasted, and 37 million were overweight in 2022, which means that malnutrition in its various manifestations still remains a significant menace to child survival and development on a global scale. Child undernutrition has a skewed burden of South Asia, which contributes to almost a third of the number of stunted children in the globe (Rahman et al., 2023). With a population of five hundred and seventy seven million people, Pakistan is already the fifth most populous nation in the world, and yet, child undernourishment rates remain alarmingly high in the nation despite the ongoing economic growth and growing health resources (Gillani et al., 2022). The Pakistan Demographic and Health Survey (PDHS) 201718 statistics revealed that some 38 per cent of under-five-year-old children were stunted, 23 per cent were underweight, and 7 per cent were wasted, which makes Pakistan one of the most affected countries in the region. These statistics underscore the necessity of situational-specific evidence to be used to make effective nutrition policies and interventions (Callen et al., 2025). Child undernutrition is a multifactorial phenomenon that is affected by a combination of immediate, underlying and basic factors. These determinants are grouped in the UNICEF conceptual model of malnutrition into inadequate dietary intake and illness at the immediate level; insufficient household food security, inadequate dietary practices, poor environment, and insufficient health services at the underlying level; and macro level socioeconomic, political, and institutional factors (Ahun et al., 2023). It is important to know how these factors interact in particular settings to design specific and effective interventions. There exists a large amount of literature attributing the influence of socioeconomic status in determining the outcomes of child nutrition. The household poverty limits access to proper food, medical care, sanitation, and education, which are vital in the healthy development of children (Ferrara et al., 2024). In LMICs, consistent studies show that wealth-related gradients in terms of stunting and underweight are very sharp, with the children in the poorest households having extremely high chances of developing chronic undernutrition. In Pakistan, socioeconomic inequalities are still high between provinces and districts that only worsen nutritional inequalities (Naz et al., 2025). The maternal factors especially education, age at birth have also been singled out as a major determinant of child undernutrition. Mother education increases health knowledge, caregiving skills, and consumption of preventive health services, which leads to a better practice of child feeding and health outcomes (Prasetyo et al., 2023). South Asian and Sub Saharan Africa evidence points to the fact that over time, female education has played a significant role in reducing child stunting (Akseer et al., 2022). On the other hand, there has been an implication of greater risks of low birth weight and poor child development among adolescent mothers because of the biological immaturity and disadvantage in socioeconomic status (Sámano et al., 2025). Factors of birth such as low birth weights and insufficient birth intervals are important determinants of early childhood development trajectory (Gansaonré et al., 2023). Small born and closely spaced children also have higher chances of growth faltering because of maternal nutritional loss and impaired fetal development. These dangers are more specifically applicable in the environment like Pakistan where fertility level is high and family planning services are not evenly distributed (Khan et al., 2024). Prevention of undernutrition is centred on

feeding practices during infancy and early childhood. Breastfeeding in the early stages of the child i.e. the first six months of life offers the best nutritional value and protective measures against infection whereas adequate supplemental feeding at the right time and age is necessary to promote healthy growth after the infancy (Ajmal, 2024). The lack of dietary diversity in young children has been closely associated with the lack of micronutrients and underweight in LMICs. Nevertheless, there is a vast difference in feeding practices between regions and socioeconomic groups in Pakistan, highlighting the importance of locally specific evidence (Waseem et al., 2025). Stunting and underweight indicators of chronic nutritional deprivation, wasting is more strongly linked with acute illness, infection and environmental exposures. The presence of poor water, sanitation, and hygiene (WASH) conditions raise the chances of enteric infections and environmental enteric dysfunction, which undermines the absorption of nutrients, leading to acute malnutrition (Abou-Seri et al., 2022). Unfinished immunization and lack of access to healthcare also contribute to vulnerability to wasting by making people vulnerable to preventable illnesses (Baidya et al., 2025). The research on child undernutrition in Pakistan has numerous gaps even though it has been conducted on a large scale. Most research papers are based on national-level research, which obscures high levels of sub-provincial and district-level heterogeneity, especially in Punjab, which is the most populous province of the country. Besides, there is a scarcity of existing evidence that studies the determinants of stunting, underweight and wasting together in the same analytical framework particularly at the district levels. It is important to address these gaps to offer geographically focused and age differentiated nutrition interventions. Thus, the current research was meant to investigate the socioeconomic, maternal, child-related, and environmental predictors of undernutrition in children below five years old in chosen districts of Punjab, Pakistan. This research offer evidence in a way that is comprehensive by comparing stunting, underweight and wasting to inform the design of integrated and context-specific approaches to reduce child undernutrition and make further progress towards national nutrition targets and sustainable development goals.

## METHODOLOGY

### Study design and setting

This research was cross-sectional analytical design and it was done in some districts of the Punjab province in Pakistan. The most populous province of the country, Punjab, exhibits high socioeconomic, demographic, and urban-rural disparity that determines child health and nutritional results. To represent the different geographical areas and development profiles in the province, the study was conducted in the districts of Lahore, Faisalabad, Multan, Bahawalpur, and Rawalpindi that were purposely chosen. Lahore and Rawalpindi are major cities and peri-urban areas that have relatively greater access to health services whereas Faisalabad and Multan are mixed urban-rural areas. Bahawalpur is a relatively underdeveloped district of the south of Punjab which has more poverty and lacks access to healthcare and sanitation facilities. The aspect of including the districts of the north, central and southern Punjab provides internal representativeness of the study in the province.

### Data source and population of the study

The research population was made up of children under 0 to 59 months years of age in the selected districts during the collection period. The survey was conducted on the basis of a household-based survey with the use of a structured questionnaire based on the instruments of the Pakistan Demographic and Health Survey (PDHS) and Multiple Indicator Cluster Survey (MICS). Multi stage sampling was used. The sampling in the first stage involved the selection of urban and rural enumeration areas in every district by probability proportional to size sampling. At the second stage, systematical sampling of the households having at least one child below the age of five years was done in every enumeration area. Intra-household clustering was avoided by randomly selecting one of the children present in a household when there were more than one eligible child in that household. The children who had complete and biologically plausible anthropometric measures were included in the analysis and those who had

missing or implausible anthropometric measures were excluded. The analytical sample was finally reduced to 3,200 children who were below the age of five.

**Outcome variables Measuring the outcome variables**

This intervention measured child nutritional status based on three anthropometric indicators of stunting, underweight, and wasting. These were established results based on the World Health Organization (WHO) Child Growth Standards. Stunting was considered with a height-age z-score of less than -2 standard deviations, underweight as a weight-age z-score of less than -2 standard deviations and wasting as a weight-height z-score of less than -2 standard deviations. The anthropometric indices were based on the WHO reference standards and then coded as binary variables of either having undernutrition or not.

**Explanatory variables are selected and measured**

The choice of explanatory variables relied on the UNICEF conceptual framework of child undernutrition and applicable empirical researchers. Child level variables were age in months, sex, reported birth size, recent morbidity (fever or diarrhea within the two weeks before the survey) and immunization status. Several maternal-level variables included the maternal age at birth of children, maternal education, birth interval, and skilled birth attendance. The household level features were household wealth status, physical place of residence, and household food security. Environmental factors consisted of drinking water source and sanitation facility that was present in the household.

**Statistical analysis**

All data were typed, cleaned and analyzed in SPSS version 26.0. The summary of the features of the study population was provided with the help of descriptive statistics and estimations of prevalence of stunting, underweight, and wasting were done in percentages in categories of explanatory variables. Chi-square tests were first used to test associations between independent variables and nutritional outcomes. Bivariate analysis indicated a p-value that was below 0.20 meaning that variables were considered to be included in multivariate models. Stunting, underweight, and wasting were fitted to separate multivariate logistic regression models that determined the independent determinants. Odds ratios were presented adjusted using 95 percent confidence intervals. Additional age-stratified models were also fitted on underweight to determine age specific determinants. The statistical significance was determined as $p < 0.05$. The variance inflation factor was used to evaluate multicollinearity amongst explanatory variables and no evidence of undesirable multicollinearity was found.

**Ethical considerations**

The study received ethical approval in the concerns of the relevant Institutional Research Ethics Committee. Parents or primary caregivers had signed the informed consent forms before data collection. The respondents were free to participate in the study and the confidentiality and anonymity of all respondents was also maintained at all times.

## RESULTS

**1. Descriptive characteristics and prevalence of undernutrition**

The number of children aged 059 months included in the analysis is 3200. The general stunting, underweight, and wasting were 29.6, 23.1, and 8.9, respectively. Stunting and underweight were more common with age, whereas wasting was more common among children of fewer ages, especially infants aged 011 months (Table 1). Male children tended to be affected more by all the types of undernutrition than female children. The prevalence of stunting (38.9%), underweight (31.7%), and wasting (13.5%) was significantly higher in children who were small at birth (less than 3.5kgs) compared with children with an average or large birth size. High levels of socioeconomic inequality were identified, and children who belong in the lowest wealth quintile by household and those born to mothers with no formal schooling have the highest rates of facing undernutrition (Table 1).

Table 1. Prevalence of child undernutrition by selected characteristics (n = 3,200)

| Variable | Category | Stunting (%) | Underweight (%) | Wasting (%) |
|---|---|---|---|---|
| **Child age (months)** | 0-11 | 18.4 | 14.6 | 12.1 |
| | 12-23 | 29.7 | 22.8 | 9.4 |
| | 24-35 | 31.2 | 24.1 | 8.7 |
| | 36-47 | 33.5 | 25.0 | 7.3 |
| | 48-59 | 32.1 | 23.9 | 7.8 |
| **Sex** | Male | 31.4 | 24.6 | 9.6 |
| | Female | 27.8 | 21.3 | 8.2 |
| **Birth size** | Small | 38.9 | 31.7 | 13.5 |
| | Average | 28.1 | 21.9 | 8.6 |
| | Large | 22.6 | 17.4 | 6.9 |
| **Maternal education** | No education | 40.2 | 32.5 | 11.8 |
| | Primary | 28.7 | 22.4 | 8.9 |
| | Secondary or higher | 17.9 | 13.8 | 6.3 |
| **Household wealth** | Lowest | 42.6 | 34.1 | 12.7 |
| | Middle | 27.4 | 21.2 | 8.4 |
| | Highest | 16.8 | 12.9 | 6.1 |

Figure 1 illustrates the distribution of stunting, underweight, and wasting by maternal education, showing a consistent decline in undernutrition prevalence with increasing educational attainment.

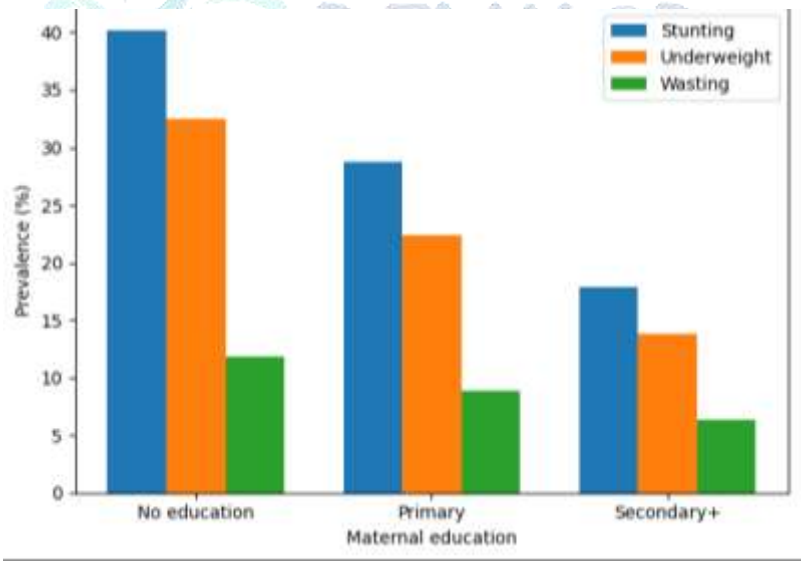


**Figure 1: Prevalence of child undernutrition by maternal education**

Similarly, Figure 2 demonstrates a strong wealth-related gradient, with the highest prevalence observed among children from the poorest households.

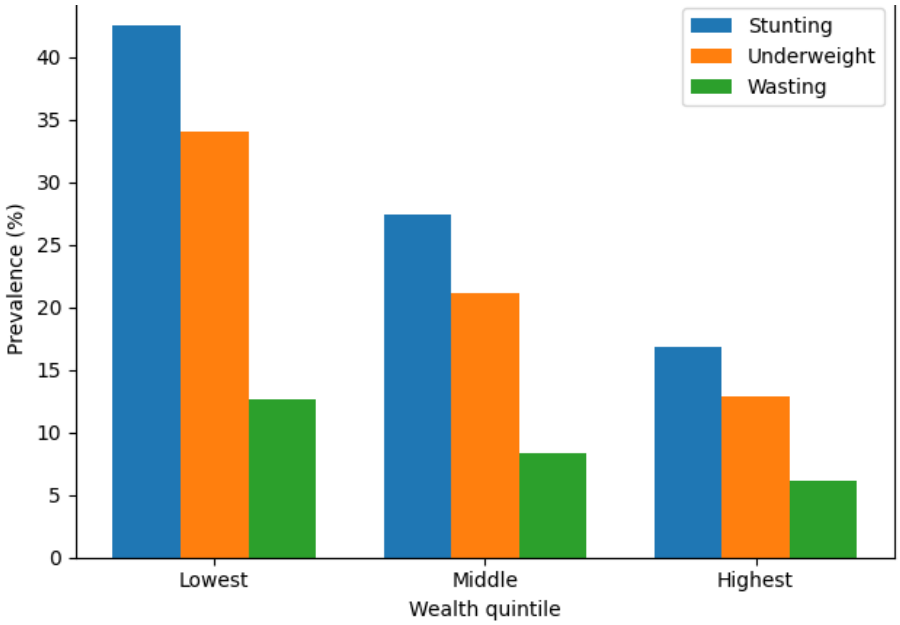


**Figure 2: Prevalence of child undernutrition by household wealth**

**2. Determinants of stunting among children under five**

Multivariate logistic regression analysis showed that there were a number of factors that were independently correlated with stunting (Table 2). There were large differences in odds of being stunted in children born with a small birth size (AOR = 1.48, 95% CI: 1.291.69, p = 0.001). Stunting was also closely related to a short birth interval (<24 months) (AOR = 1.57, 95% CI: 1.361.81). The strongest associations were observed between socioeconomic factors. Children of mothers with no formal education were almost twice as likely to be stunted (AOR = 1.92, 95% CI: 1.612.29), and those in the lowest wealth quintile were more than two times more likely to be stunted than children in the highest quintile (AOR = 2.41, 95% CI: 1.982.93). Examples of poor sanitation environment and recent diarrheal disease were also found to be strongly linked with the high stunting risk.

**Table 2. Multivariable logistic regression analysis of determinants of stunting**

| Predictor | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Small birth size | 1.48 | 1.29–1.69 | <0.001 |
| Birth interval <24 months | 1.57 | 1.36–1.81 | <0.001 |
| Maternal age <20 years | 1.34 | 1.10–1.64 | 0.003 |
| No maternal education | 1.92 | 1.61–2.29 | <0.001 |
| Lowest wealth quintile | 2.41 | 1.98–2.93 | <0.001 |
| Poor sanitation exposure | 1.18 | 1.02–1.37 | 0.026 |
| Recent diarrhea | 1.21 | 1.05–1.40 | 0.009 |

**3. Age-specific determinants of underweight**

Analyses of underweight that were done based on age showed disparate determinants (Table 3). The small birth size was still a good predictor at all ages with the highest effect on infants (0-5 months) (AOR = 2.18, 95% CI: 1.65-2.87). There were shown age specific effects in feeding practices. Absence of exclusive breastfeeding was greatly implicated with underweight among infants (AOR = 2.06), whereas insufficient dietary diversity was a

significant influence among children of 635 months (AOR = 1.41). Underweight among all ages was always linked to maternal education and household food insecurity. Figure 4 depicts the relative strength of underweight determinants on age groups.

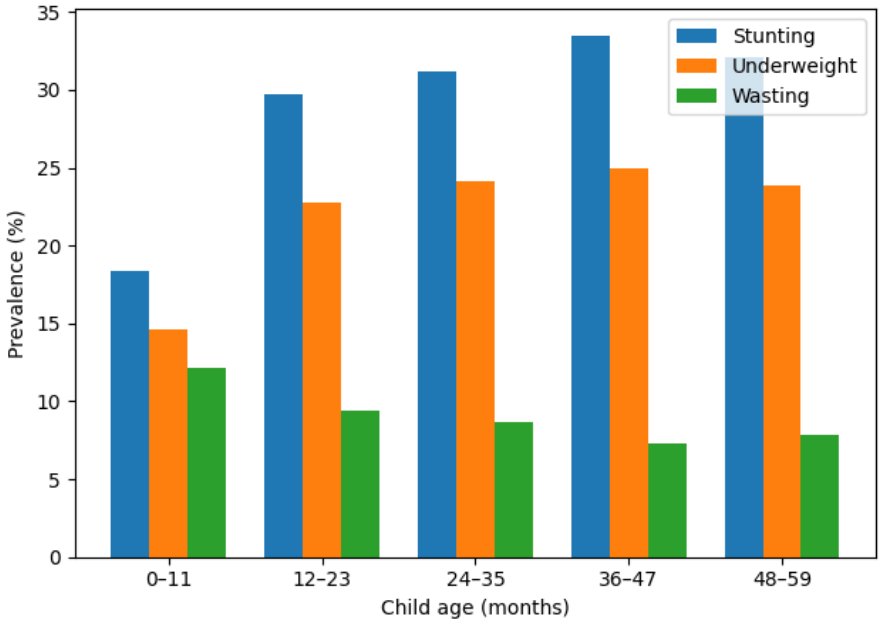


**Figure 4: Age-specific determinants of underweight**

**Table 3. Determinants of underweight by age group**

| Predictor | 0–59 months OR (95% CI) | 6–35 months OR (95% CI) | 0–5 months OR (95% CI) |
|---|---|---|---|
| Small birth size | 1.62 (1.40–1.88) | 1.71 (1.43–2.05) | 2.18 (1.65–2.87) |
| Inadequate dietary diversity | 1.29 (1.12–1.49) | 1.41 (1.19–1.67) | — |
| No exclusive breastfeeding | — | — | 2.06 (1.44–2.96) |
| No maternal education | 1.71 (1.47–1.99) | 1.86 (1.55–2.23) | 1.38 (1.02–1.86) |
| Household food insecurity | 1.53 (1.32–1.78) | 1.61 (1.35–1.92) | 1.44 (1.03–2.01) |

**4. Determinants of wasting among children under five**

The determinants of wasting were different as compared to chronic undernutrition (Table 4). Smaller birth size was an important predictor of wasting (AOR = 1.39, 95% CI: 1.16 -1.66). Wasting was also found to have significant associations with acute morbidity indicators, such as recent fever and incomplete immunization. The factors of environmental and maternal healthcare were significant. Children who were exposed to insecure drinking water and those who were born without professional birth care had a high chance of wasting.

Table 4. Multivariable logistic regression analysis of determinants of wasting

| Predictor | Adjusted OR | 95% CI | p-value |
|---|---|---|---|
| Small birth size | 1.39 | 1.16–1.66 | <0.001 |
| Recent fever | 1.22 | 1.05–1.42 | 0.010 |
| Incomplete immunization | 1.18 | 1.01–1.38 | 0.037 |
| Unsafe drinking water | 1.27 | 1.05–1.53 | 0.014 |
| No skilled birth attendance | 1.41 | 1.09–1.82 | 0.009 |
| No maternal education | 1.24 | 1.03–1.50 | 0.021 |

## DISCUSSION

This research examined the socioeconomic, maternal, and child-based determinants of undernutrition among children below the age of five years and in matters of stunting, underweight, and wasting. The results indicate that undernutrition is a multidimensional social health issue that is perpetuated by structural poverty, maternal factors, conditions during early development in life, and illness exposure. In general, the findings fit into the UNICEF conceptual framework of child malnutrition that puts the focus on the interplay between short- and long-term and structural factors in influencing child nutrition outcomes. In this study, household socioeconomic status was found to be one of the best predictors of stunting and underweight. The children in the least wealthy quintile were comparatively more prone to face chronic types of undernutrition which highlights the significance of poverty in restricting the accessibility to sufficient food, health care and clean living circumstances. This result aligns with international and regional data that show that socioeconomic deprivation is a key factor of child growth failure in low- and middle-income countries (LMICs) (Smith and Haddad, 2015; Alderman and Headey, 2017). Wealth-related gradients in child undernutrition have also been reflected in the national surveys of South Asia and Sub-Saharan Africa and in Pakistan in the Demographic and Health Survey (NIPS , 2019; Headey et al., 2020). Mother education was one more overwhelming factor in all the nutritional outcomes. The children of mothers who were not educated had significantly greater chances of stunting, underweight and wasting. This result is consistent with a substantial amount of literature indicating that maternal education positively affects child nutrition due to better caregiving practices, improved health-seeking behavior, and increased resource allocation in the household (Caldwell, 1979). Smith and Haddad (2015) showed that increased female education contributed to significant shares of child stunting reduction in the world in 1970, which indicates that education is a structural long-term intervention. All types of undernutrition in this study were all related to birth-related factors especially small birth size. Small children were in much greater danger of both chronic and acute malnutrition as is the long-term outcome of intrauterine growth limitation and inadequate maternal nutrition during a pregnancy. These results are consistent with the large multicountry studies that indicate that low birth weight and small-for-gestational-age births significantly predispose to stunting, wasting, and childhood mortality (Black et al., 2013; Christian et al., 2013). The stunting was strongly linked with short birth spacing and this supports the maternal depletion hypothesis, according to which a close birth spacing affects maternal nutritional resources and fetal development. Such a relationship is reported to be consistent across a variety of environments such as South Asia and Latin America (Conde-Agudelo et al., 2006). Interventions that are aimed at optimal birth spacing are therefore still an important part of the strategies that work to alleviate chronic undernutrition. The findings showed that there were age-specific trends in undernutrition determinants. In the case of infants 0-5 months old, the absence of exclusive breastfeeding was highly correlated with underweight, which demonstrated the protective nature of the best infant feeding patterns in early childhood.

Breastfeeding offers sufficient nutritional and immune systems, minimizing the chances of growth faltering as a result of infections (Victora et al., 2016). This has also been associated with other LMICs, where similar correlations have been noted between poor breastfeeding and poor undernutrition in early childhood (Khan et al., 2019; Tessema et al., 2021). However, in children aged 635 months, dietary diversity was found to be a determinant of underweight. This change indicates the growing role of the quality of complementary feeding as children move on to family foods. Past research has continuously indicated that there is a relationship between low dietary diversity and the presence of micronutrient deficiencies and poor growth in young children (Arimond & Ruel, 2004; Dewey, 2016). Wasting, in comparison with stunting and underweight, was more closely related to such acute issues as recent febrile disease, incomplete immunization, use of unsafe drinking water, and absence of competent birth attendance. Such results confirm the perception of the fact that wasting is a reflection of temporary nutritional shocks and disease outbreaks but not in the long term deprivation. The connection between unsafe drinking water and wasting contributes to the evidence of the association between enteric infections and environmental enteric dysfunction and the acute malnutrition (Humphrey, 2009; Prendergast and Humphrey, 2014). Lack of full immunization and current sickness were also important predictors of wasting which underscores the role of preventive healthcare in minimizing acute malnutrition. South Asian and Sub-Saharan studies revealed that unvaccinated children were at a greater risk of losing weight to infection and dying (Owais et al., 2011; Black et al., 2013). The results indicate the necessity of combined nutrition and child health programs. This research indicates that the implementation of effective ways to address the issue of child undernutrition should be age-specific and multisectoral. The interventions aimed at curbing chronic undernutrition should focus on poverty reduction, education of women, maternal nutrition, and ideal birth spacing. Conversely, the approach to curbing wasting must be built upon the enhancement of primary healthcare, adequacy in immunization, availability of safe drinking water, and the best infant and young child feeding behaviors. These are the combined measures necessary to fulfill the Sustainable Development Goal 2 area of eliminating any types of malnutrition by 2030.

## Conclusion

The present paper shows that the problem of child undernutrition in certain districts of Punjab in Pakistan is a major public health issue, which is predetermined by the complex of socioeconomic, maternal, biological, and environmental factors. Household poverty, low maternal education and poor birth characteristics were closely related to chronic forms of undernutrition, whereas illness, poor water safety, limited access to healthcare was more related to acute malnutrition. The results indicate the need to use multisectoral age-specific approaches which combine poverty decrements, education of the women, healthcare of the women as well as children and enhancement of the water and sanitation. This kind of coordinated action is necessary to produce sustained child undernutrition reduction and move towards national and global nutrition goals.

## References

Abou-Seri, H., Abdalgaber, M., & Zahran, F. (2022). Enteric parasitic infections: From environmental enteric dysfunction to gut microbiota and childhood malnutrition. *Parasitologists United Journal*, *15*(3), 216-223.

Ahun, M. N., Aboud, F., Wamboldt, C., & Yousafzai, A. K. (2023). Implementation of UNICEF and WHO's care for child development package: Lessons from a global review and key informant interviews. *Frontiers in public health*, *11*, 1140843.

Ajmal, R. (2024). Promoting breastfeeding and complementary feeding practices for optimal maternal and child nutrition. *Pakistan Journal of Public Health*, *14*(Special. NI), 168-180.

Akseer, N., Tasic, H., Onah, M. N., Wigle, J., Rajakumar, R., Sanchez-Hernandez, D., ... & Hoddinott, J. (2022). Economic costs of childhood stunting to the private sector in low-and middle-income countries. *EClinicalMedicine*, *45*.

Alderman, H., & Headey, D. D. (2017). How important is parental education for child nutrition?. *World development*, *94*, 448-464.

Arimond, M., & Ruel, M. T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *The Journal of nutrition*, *134*(10), 2579-2585.

Baidya, A., Willens, V., Wonodi, C., & Moss, W. J. (2025). Maintaining Immunizations for Vaccine-Preventable Diseases in a Changing World. *Annual review of public health*, *46*.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., De Onis, M., ... & Uauy, R. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *The lancet*, *382*(9890), 427-451.

Caldwell, J. C. (1979). Education as a factor in mortality decline an examination of Nigerian data. *Population studies*, 395-413.

Callen, M., Gulzar, S., Hasanain, A., Khan, M. Y., & Rezaee, A. (2025). Personalities and public sector performance: evidence from a health experiment in Pakistan. *Economic Development and Cultural Change*, *73*(3), 1439-1474.

Christian, P., Lee, S. E., Donahue Angel, M., Adair, L. S., Arifeen, S. E., Ashorn, P., ... & Black, R. E. (2013). Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low-and middle-income countries. *International journal of epidemiology*, *42*(5), 1340-1355.

Conde-Agudelo, A., Rosas-Bermúdez, A., & Kafury-Goeta, A. C. (2006). Birth spacing and risk of adverse perinatal outcomes: a meta-analysis. *Jama*, *295*(15), 1809-1823.

Dewey, K. G. (2016). Reducing stunting by improving maternal, infant and young child nutrition in regions such as South Asia: evidence, challenges and opportunities. *Maternal & child nutrition*, *12*, 27-38.

Ferrara, P., Cammisa, I., Zona, M., Corsello, G., Giardino, I., Vural, M., ... & Pettoello-Mantovani, M. (2024). Child opportunity index: a multidimensional indicator to measure neighborhood conditions influencing children's health. *The Journal of Pediatrics*, *264*.

Gansaonré, R. J., Moore, L., Kobiané, J. F., Sié, A., & Haddad, S. (2023). Birthweight, gestational age, and early school trajectory. *BMC Public Health*, *23*(1), 1032.

Gillani, S., Shafiq, M. N., Bhatti, M. A., & Ahmad, T. I. (2022). Impact of economic growth on child malnutrition in Pakistan: a time series analysis. *iRASD Journal of Economics*, *4*(1), 149-163.

Headey, D., Heidkamp, R., Osendarp, S., Ruel, M., Scott, N., Black, R., ... & Walker, N. (2020). Impacts of COVID-19 on childhood malnutrition and nutrition-related mortality. *The Lancet*, *396*(10250), 519-521.

Humphrey, J. H. (2009). Child undernutrition, tropical enteropathy, toilets, and handwashing. *The Lancet*, *374*(9694), 1032-1035.

Khan, N. U., Asif, N., Zehrh, I., Mg, G., Arshad, S., & Changez, M. I. K. (2024). Fertility patterns in Pakistan: a comparative analysis of family planning trends across different geographic regions. *Rural and Remote Health*, *24*(3), 1-8.

Khan, S., Zaheer, S., & Safdar, N. F. (2019). Determinants of stunting, underweight and wasting among children< 5 years of age: evidence from 2012-2013 Pakistan demographic and health survey. *BMC public health*, *19*(1), 358.

Morales, F., Montserrat-De la Paz, S., Leon, M. J., & Rivero-Pino, F. (2023). Effects of malnutrition on the immune system and infection and the role of nutritional strategies regarding improvements in children's health status: A literature review. *Nutrients*, *16*(1), 1.

National Institute of Population Studies (NIPS)[Pakistan]. (2019). Pakistan demographic and health survey 2017–18. *National Institute of Population Studies Pakistan and ICF*.

Naz, L., Ali, A., Yasmin, S., & Trueha, K. (2025). Geospatial inequalities in women's malnutrition in Pakistan. *BMC Women's Health*, *25*(1), 225.

Owais, A., Hanif, B., Siddiqui, A. R., Agha, A., & Zaidi, A. K. (2011). Does improving maternal knowledge of vaccines impact infant immunization rates? A community-based randomized-controlled trial in Karachi, Pakistan. *BMC public health*, *11*(1), 239.

Prasetyo, Y. B., Permatasari, P., & Susanti, H. D. (2023). The effect of mothers' nutritional education and knowledge on children's nutritional status: a systematic review. *International Journal of Child Care and Education Policy*, *17*(1), 11.

Prendergast, A. J., & Humphrey, J. H. (2014). The stunting syndrome in developing countries. *Paediatrics and international child health*, *34*(4), 250-265.

Rahman, M. M., de Silva, A., Sassa, M., Islam, M. R., Aktar, S., & Akter, S. (2023). A systematic analysis and future projections of the nutritional status and interpretation of its drivers among school-aged children in South-East Asian countries. *The Lancet Regional Health-Southeast Asia*, *16*.

Sámano, R., Chico-Barba, G., Godínez-Martínez, E., Martínez-Rojano, H., Díaz-Medina, A., Hernández-Trejo, M., ... & Luna-Espinosa, V. S. (2025). Differential Effects of Gynecological and Chronological Age on Low Birth Weight and Small for Gestational Age. *Biomedicines*, *13*(7), 1639.

Smith, L. C., & Haddad, L. (2015). Reducing child undernutrition: past drivers and priorities for the post-MDG era. *World Development*, *68*, 180-204.

Victora, C. G., Bahl, R., Barros, A. J., França, G. V., Horton, S., Krasevec, J., ... & Rollins, N. C. (2016). Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *The lancet*, *387*(10017), 475-490.

Waseem, M., Jamil, I., Islam, A. H. M. S., Mughal, B., Alnafissa, M., & Alamri, Y. A. (2025). Enhancing Dietary Diversity and Nutritional Security Through Farm Production Diversity: Evidence From Rain-Fed Regions in Southern Punjab, Pakistan. *Food and Energy Security*, *14*(3), e70101.