Determinants of stunting, underweight and wasting among children < 5 years of age: evidence from 2012-2013 Pakistan demographic and health survey

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Abstract

Background: Childhood malnutrition is a critical public health concern in Pakistan. We aimed to explore factors associated with malnutrition in Pakistani children (< 5 years of age) using the Pakistan Demographic and Health Survey (PDHS) 2012–2013.

Methods: Sample of 3071 Pakistani children aged 0–59 months from the PDHS 2012–2013, with complete anthropometric measurements were included in the study. Nutritional status was evaluated using anthropometric indices; height-for-age, weight-for-height and weight-for-age, as proxy measures of three forms of under-five malnutrition including stunting, wasting and underweight respectively. Uni- and multivariate binary logistic regressions were used to examine the association between selected maternal-socio-demographic and child level variables (such as child sex, age, size at birth, antenatal clinic visits, recent diarrheal incidence and breastfeeding status) and three proxy measures of child nutritional status.

Results: About 44.4% of under-five children were stunted, 29.4% were underweight and 10.7% were wasted. Children whose mothers lived in rural areas (aOR = 0.67, 95%CI 0.48–0.92), were aged ≥18 years at marriage (aOR = 0.76, 95%CI 0.59–0.92) and had visited antenatal clinic more than 3 times during pregnancy (aOR = 0.61, 95%CI 0.38–0.98) were less likely to be stunted. Mother’s low educational level (aOR = 2.55, 95%CI 1.26–5.17), short stature (aOR = 2.31, 95%CI 1.34–3.98), child’s small size at birth (aOR = 1.67, 95%CI 1.14–2.45) and mother’s BMI were significantly associated with child’s underweight status. Children whose mothers had no education were more likely to be wasted (aOR = 3.61, 95%CI 1.33–9.82).

Conclusion: The study suggests that most of the analysed factors that accounted for malnutrition in Pakistani children (such as mother’s age at marriage, educational level and mothers’ nutritional status) are preventable. Therefore, to reduce the burden of malnutrition interventions that can address these factors are required such as community based education and targeted nutritional interventions.

Keywords: Malnutrition, Stunting, Wasting, Underweight, Children

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Background

Malnutrition remains a critical public health problem among children under the age of five years in developing countries including Pakistan. Malnutrition is caused by multiple interlinked factors and has both short and long term detrimental health effects [1, 2]. It affects the cognitive and physical development of children, increases the risk of infections and significantly contributes to the child’s morbidity and mortality [3, 4]. Stunting, wasting and underweight are three widely recognized indicators of child’s nutritional status [5]. While stunting and wasting indicates chronic and acute malnutrition respectively, underweight is a composite indicator and includes both acute (wasting) and chronic (stunting) malnutrition [5]. However, different forms of malnutrition can also occur concurrently in children [6].

Malnutrition significantly contributes to the global burden of several diseases. Globally, undernutrition accounts for at least half of all the deaths annually in children under five [7]. In 2016, according to World Health Organization (WHO), at least 155, 52 and 99 million children under the age of five years were stunted, wasted and underweight worldwide respectively [8, 9]. In addition, around 6 million children were reported with stunting and wasting simultaneously [6]. Malnutrition is clustered in developing countries, particularly in Africa and South Asia [9, 10]. In South Asia, three countries of the region, India, Pakistan and Bangladesh, have particularly high prevalence of the condition [11].

In Pakistan, malnutrition is the major contributor of morbidity and mortality in children under five years of age, and the country ranks 22nd in the world for under-five child mortality [12, 13]. The 2011 national nutrition survey reported that 44% of under-five children in Pakistan were stunted, 15% were wasted and 31% were underweight [14]. The high magnitude of all three indicators of malnutrition in country reflects the poor nutritional and health status among under-fives in country, thus necessitating the need to conduct this study to explore factors associated with malnutrition in Pakistani children.

There are multiple factors that contribute to childhood malnutrition. The common determinants reported by several studies include socioeconomic inequalities, geographical differences, suboptimal feeding practices, household food insecurity, maternal literacy and childhood morbidities [15–19]. Previous studies that have been conducted on childhood malnutrition in Pakistan were mostly based on hospital, schools, regional and community settings [20–23]. Limited studies, that have reported the national level data, were either restricted to socio-demographic determinants or children less than two years of age [24, 25]. In addition, there is a paucity of literature regarding the correlates of all three indicators of childhood malnutrition in the country based on nationally representative data set. Therefore, the current study utilized the nationally representative Pakistan Demographic and Health Survey (PDHS) 2012–2013 data, to examine the factors associated with malnutrition among Pakistani children aged 0–59 months.

Methods

Study design

Cross-sectional.

Data set

Secondary analysis of the PDHS 2012–2013 data set was carried out. The PDHS 2012–2013 was a nationally representative third survey conducted by the National Institute of Population Studies (NIPS), Pakistan, as a part of the international MEASURE DHS (Demographic and Health Surveys) program. The survey was carried out with the support of ICF International and United States Agency for International Development (USAID) [26]. This survey collected the information of Pakistani households related to socio-demographic, maternal and child health indicators [26].

Study sampling and participants

A two stage stratified sampling design was used in order to obtain a nationally representative sample of Pakistani households for the PDHS 2012–2013. The survey included the rural and urban population of all four provinces of Pakistan (Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan) and regions of Gilgit Baltistan and Islamabad Capital Territory (ICT). However, the survey did not collect the data from some parts of the country including Federally Administered Tribal Areas (FATA), Azad Jammu and Kashmir (AJK) and restricted military areas due to security concerns [26]. For the purpose of the PDHS 2012–2013, 13,944 households were selected and interviews were successfully completed in 96% households by trained interviewers using the structurally validated questionnaire. Women who were ever married (n = 14,569, age 15–49 years) were interviewed and anthropometric measurements of eligible children (n = 3466) were recorded from a subset of these households. Eligible children included were born within the five years preceding the survey and had valid record of dates of birth. Measurements of children were recorded for both height (in centimeter) and weight (in kilograms) using the digital SECA scales and measuring boards of Shorr productions. Recumbent length was measured in children who were either less than 2 years of age or 85 cm in length and for the rest standing height was measured [26].

The sample of children (n = 3071, aged 0–59 months) that had complete anthropometric measurements were
selected from the subset of eligible children \(n = 3466\) for the current analysis.

**Evaluation of nutritional status of children < 5 years of age**

We used three widely recognized anthropometric indices (height-for-age, weight-for-height and weight-for-age) to assess the nutritional status of under-five children in the PDHS 2012–2013 data set. The WHO Multicenter Growth Reference Study was used to calculate the three anthropometric indices in order to evaluate the nutritional status [27]. The three indices were expressed in standard deviation (SD) units from reference population median. Children with Z-scores below -2SD from the WHO reference population median, for height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) were considered stunted, wasted and underweight respectively [26].

**Study variables**

The coding plan of the selected study variables is given in Table 1. To examine the factors linked with nutritional status of the children less than 5 years of age, dependent variables were expressed as dichotomous variables. The variables included category 0 [not stunted (>−2SD), not wasted (>−2SD to +2SD) and not underweight (>−2SD)] and category 1 [stunted (≤−2SD), wasted (≤−2SD) and underweight (≤−2SD)]. Obese children (WHZ above +2SD, \(n = 208\)) were not included in the analysis of wasted children (Table 2).

Explanatory variables were selected after conducting a detailed literature review [15–17, 19, 23, 24, 28] and only those variables showing association with nutritional status of children and also available with complete information in the PDHS 2012–2013 data set were included in the current analysis. Selected explanatory variables were divided into two levels which included sociodemographic-maternal and child-level factors. Socio demographic-maternal factors selected were types of residence, household wealth index, mother’s educational level, employment status, age at marriage, parity, access to information, consanguineous marriage, mother’s height and mother’s body mass index (BMI). Child-level factors were sex of child, child age, child size at birth, antenatal clinic visits, recent diarrheal incidence and breastfeeding status.

**Statistical analysis**

We used software SPSS 16.0 and SAS 9.1 for data analysis. Analysis was done by descriptive statistics and logistic regressions. Descriptive statistics were used to generate frequencies and to describe the study variables. Univariate and multivariate binary logistic regressions were used to examine the determinants of all three indices of child nutritional status. Prevalence of nutritional status in the population and all the regression analysis models were adjusted to consider the complex sampling design of the PDHS 2012–2013. The adjustment was made by including the primary sampling units, final weights and strata in the models.

Two step wise models were constructed for the study, based on the categorization of the independent variables into sociodemographic-maternal and child level factors. Model 0 reported the univariate association between child nutritional status and all independent study variables. Model 1 showed adjusted associations after including type of residence, wealth index, mother’s education level, employment status, age at marriage, parity, access to information, consanguineous marriage, mother’s height and BMI. Model 2 reported the results after adjusting for child level factors which includes child age, sex, perceived child weight at birth, antenatal clinic visits, recent diarrheal incidence, and breastfeeding status. Results were given as crude odds ratios (cOR) and adjusted odds ratios (aOR) with 95% confidence intervals (CI). \(P\)-values < 0.05 were considered statistically significant.

**Ethical review**

The PDHS 2012–2013 has taken into account the standard ethical guidelines of the measure DHS program [26]. The authors have obtained the data from MEASURE DHS website (URL: https://www.dhsprogram.com/data/available-datasets.cfm) following their data obtaining procedure. However, no formal ethical clearance was obtained because the study involved secondary analysis of publicly available data.

**Results**

A total of 3071 children aged 0–59 months were included in the study. Stunting (44.4%) was the most common nutritional abnormality observed in this study followed by underweight (29.4%) and wasting (10.7%) (Table 2). Background characteristics of studied children are presented in Table 3. Briefly, mean age of the children was 2.1 years (SD 1.4) of which majority were males (50.7%), lived in rural areas (56.7%) and had mothers with no formal education (52.3%). Only 20.4% of the children had mothers with secondary education and 79.1% of the interviewed mothers were not working. About 20.6% of the children were from poorest households, whereas, 19.9% of the children were from richest households. According to the maternal characteristics, 41.7% of children had mothers who were married before 18 years of age, 62.3% had mothers who were consanguineously married and 32.9% had mothers who had given birth to more than 5 children. About 22.3% of the children had mothers who did not visit any antenatal clinic during pregnancy, 28.0% had mothers who did not
### Table 1 Description and analysis coding plan of the selected study variables

| Variables                     | Description and Categorization                                                                 | Analysis Coding                                                                 |
|-------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| **Outcome variable**          |                                                                                                 |                                                                                 |
| Stunting (Height-for-age index)| Height/Age standard deviation (new WHO) Continuous                                               | 0 = Normal height-for-age/Not-stunted (HAZ -2SD and Above) 1 = Stunted (HAZ < -2SD) |
| Underweight (Weight-for-age index) | Weight/Age standard deviation (new WHO) Continuous                                              | 0 = Normal weight-for-age/Not-underweight (WAZ-2SD and Above) 1 = Underweight (WAZ < -2SD) |
| Wasting (Weight-for-height index) | Weight/Height standard deviation (new WHO) Continuous                                            | 0 = Normal weight-for-height/Not-wasted (WHZ-2SD to +2SD) 1 = Wasted (WHZ < -2SD)  |
| **Independent variables**     |                                                                                                 |                                                                                 |
| Residence                     | Type of place of residence (1 = Urban, 2 = Rural)                                               | Used same coding for analysis                                                   |
| Mother’s educational level     | Highest educational level (0 = no education, 1 = primary, 2 = secondary, 3 = higher)           | Used same coding for analysis                                                   |
| Wealth index                  | Wealth index (1 = poorest, 2 = poorer, 3 = middle, 4 = richer, 5 = richest)                    | Used same coding for analysis                                                   |
| Mother’s employment status     | Respondent currently working (0 = Non-working, 1 = Working)                                    | Used same coding for analysis                                                   |
| Mother’s access to information| 1. Frequency of reading newspaper or magazine 2. Frequency of listening to radio 3. Frequency of watching television (0 = Not at all, 1 = Occasionally, 2 = Atleast once a week, 3 = Daily) | Options for all the three variables were recoded as follows 0 as 0 = No (No Access) 1,2&3 as 1 = Yes (Access to at least one of the information source) |
| Consanguineous marriage       | Blood relation with husband (0 = No, 1 = Yes)                                                   | Used same coding for analysis                                                   |
| Mother’s age at marriage      | Age at first cohabitation (Continuous, Range: 10–49)                                            | Constructed as 1 = < 18 2 = > 18                                               |
| Parity                        | Total children ever born (Continuous, Range: 1–19)                                              | Constructed as 1 = 1–4 2 = > 4 (5+)                                            |
| Mother’s height (cm)          | Respondent’s height in centimeters (1 decimal) Continuous                                        | Constructed as follows 1 = Normal (≥ 145 cm) 2 = Short Stature (< 145 cm)        |
| Mother’s BMI (kg/m²)          | Body Mass Index (Continuous, calculated using measured height and weight)                       | 1 = Underweight (< 18.5 kg/m²) 2 = Normal (18.5–24.9 kg/m²) 3 = Overweight (25.0–29.9 kg/m²) 4 = Obese (≥ 30 kg/m²) |
| Age of Child (years)          | Current age of the child (Continuous)                                                           | Constructed as 0 = < 12 months 1 = 12–23 months 2 = 24–35 months 3 = 36–47 months 4 = 48–59 months |
| Sex of child                  | Sex of child (1 = Male, 2 = Female)                                                             | Used same coding for analysis                                                   |
| Child size at birth           | Size of child at birth (1 = very large, 2 = larger than average, 3 = average, 4 = smaller than average, 5 = very small, 6 = Don’t know) | Options were recoded as follows 4 & 5 as 1 = smaller than average 3 & 6 as 2 = average 1 & 2 as 3 = larger than average |
| Antenatal clinic visits       | Number of antenatal visits during pregnancy (0 = No antenatal visit, 98 = Don’t know)           | Constructed as follows 0 & 98 as 0 = No Visit 1–3 as 1 = Less frequent visits Visit frequency > 3 as 2 = Frequent visits (3+) |
| Recent diarrheal incidence    | Had diarrhea recently (0 = No, 1 = Yes, last 24 h, 2 = Yes, last 2 weeks, 8 = Don’t Know)        | Recoded as 0 as Gas 0 = No 1&2as1 = Yes 8 = Excluded                             |
| Breastfeeding status          | Duration of breastfeeding (93 = Ever breastfeeding, 94 = Never breastfeed, 95 = Still breastfeeding, 96 = Breastfed until died, 97 = Inconsistent, 98 = Don’t know) | Used same coding for analysis (No data were found for 96, 97, 98) |

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have access to any source of information and 21.9% of the children had diarrhea in last two weeks before the survey was conducted.

**Determinants of stunting**

Univariate analysis (Model 0) indicated that children born to mothers that lived in rural areas (cOR = 1.57, 95% CI 1.25–1.96), had no education (cOR = 4.66, 95% CI 3.10–7.00), had married consanguinely (cOR = 1.64, 95% CI 1.31–2.05) and had the poorest wealth index (cOR = 5.41, 95% CI 3.91–7.48) were more likely to be stunted. Mother’s height was significantly associated with child stunting as children whose mothers had short stature (< 145 cm) were more likely to be stunted (cOR = 3.05, 95% CI 1.68–5.55). This association remained the same after the adjustment of all other factors in Model 1 and 2. However, children whose mothers were aged ≥18 years at marriage (aOR = 0.76, 95% CI 0.59–0.99) and children whose mothers had visited antenatal clinics more than 3 times during pregnancy (aOR = 0.61, 95% CI 0.38–0.98) were less likely to be stunted. Children within the age group of 24–35 months (aOR = 3.65, 95% CI 2.23–5.95) and children that were of smaller than average size at the time of birth (aOR = 1.48, 95% CI 1.02–2.16) were more likely to be stunted (Table 4).

**Determinants of underweight**

Univariate analysis (Model 0) indicated that rural residence (cOR = 1.52, 95% CI 1.17–1.97), poorest wealth index (cOR = 5.01, 95% CI 3.47–7.22), mother’s employment status (cOR = 1.38, 95% CI 1.04–1.81), consanguineous marriage (cOR = 1.74, 95% CI 1.36–2.23) and male sex of the child (cOR = 1.30, 95% CI 1.03–1.63) were risk factors for child’s low weight-for-age status. Multivariate analysis with the addition of maternal and child related factors (Model 1 and Model 2) indicated that mother’s educational level (aOR = 2.55, 95% CI 1.26–5.17), child’s small size at birth (aOR = 1.67, 95% CI 1.14–2.45) and mother’s nutritional status were significantly associated with child’s low weight-for-age status. Children whose mothers were short in height (aOR = 2.31, 95% CI 1.34–3.98) and had a BMI < 18.5 (aOR = 1.78, 95% CI 1.00–3.17) were more likely be underweight (Table 5).

**Determinants of wasting**

Multivariate analysis with the addition of maternal and child related factors (Model 1 and Model 2) indicated that children whose mothers had no education were more likely to be wasted (aOR = 3.61, 95% CI 1.33–9.82). Similarly, children whose mothers had a BMI < 18.5 were more likely to be wasted as compared to the children of obese mothers (aOR = 2.79, 95% CI 1.15–6.73) (Table 6).

**Discussion**

This study presents the risk factors associated with child malnutrition in terms of stunting, underweight and wasting among under-five Pakistani children using the 2012–2013 PDHS data. Our study showed that place of residence, wealth index, BMI of mother, mothers’ age at marriage, child size at birth and antenatal clinic visits
Table 3 Socio-demographic characteristics of Pakistani children in the age range of <5 years (n = 3071)

| Variables | Total | Stunted | Underweight | Wasted |
|-----------|-------|---------|-------------|--------|
|           | n     | %       | (%)         | (%)    |
| **Maternal factors** |       |         |             |        |
| Residence |       |         |             |        |
| Urban     | 1330  | 43.3    | 39.9        | 21.4   | 9.8    |
| Rural     | 1741  | 56.7    | 48.8        | 30.5   | 10.9   |
| Mother’s educational level |       |         |             |        |
| No education | 1606  | 52.3    | 55.0        | 34.0   | 12.3   |
| Primary   | 497   | 16.2    | 45.7        | 26.8   | 8.9    |
| Secondary | 626   | 20.4    | 29.1        | 15.7   | 8.3    |
| Higher    | 342   | 11.1    | 25.7        | 11.4   | 7.6    |
| Wealth index |       |         |             |        |
| Poorest   | 634   | 20.6    | 62.3        | 37.9   | 12.8   |
| Poorer    | 613   | 20.0    | 54.8        | 32.8   | 11.1   |
| Middle    | 554   | 18.0    | 44.0        | 25.8   | 10.6   |
| Richer    | 658   | 21.4    | 38.8        | 20.7   | 8.8    |
| Richest   | 612   | 19.9    | 24.5        | 15.7   | 8.7    |
| Mother’s employment status (n = 3064) |       |         |             |        |
| Non-Working | 2423  | 79.1    | 43.0        | 24.8   | 10.4   |
| Working   | 641   | 20.9    | 52.7        | 33.4   | 10.3   |
| Mother’s age at marriage (years) |       |         |             |        |
| < 18      | 1281  | 41.7    | 52.1        | 31.9   | 11.0   |
| ≥ 18      | 1790  | 58.3    | 39.8        | 22.7   | 9.9    |
| Parity    |       |         |             |        |
| 1–4       | 2060  | 67.1    | 40.7        | 26.4   | 10.1   |
| 5+        | 1011  | 32.9    | 53.5        | 26.9   | 10.9   |
| Mother’s access to information |       |         |             |        |
| No        | 859   | 28.0    | 54.1        | 32.5   | 12.5   |
| Yes       | 2212  | 72.0    | 41.1        | 24.3   | 9.6    |
| Consanguineous marriage |       |         |             |        |
| No        | 1159  | 37.7    | 38.4        | 21.0   | 9.8    |
| Yes       | 1912  | 62.3    | 48.9        | 30.0   | 10.7   |
| Mother’s height (cm) (n = 3064) |       |         |             |        |
| Short Stature (< 145 cm) | 132   | 4.3     | 70.5        | 50.0   | 11.4   |
| Normal (≥ 145 cm) | 2924  | 95.7    | 43.9        | 25.6   | 10.4   |
| Mother’s BMI (kg/m²) (n = 3061) |       |         |             |        |
| Underweight (<18.5 kg/m²) | 364   | 11.9    | 58.5        | 45.3   | 15.7   |
| Normal (18.5–24.9 kg/m²) | 1657  | 54.3    | 45.6        | 28.2   | 11.1   |
| Overweight (25.0–29.9 kg/m²) | 696   | 22.8    | 43.1        | 18.7   | 8.5    |
| Obese (≥ 30 kg/m²) | 336   | 11.0    | 32.1        | 16.1   | 5.1    |
| Child Factors |       |         |             |        |
| Sex of child |       |         |             |        |
| Male      | 1558  | 50.7    | 46.8        | 28.2   | 11.6   |
| Female    | 1513  | 49.3    | 43.0        | 24.9   | 9.2    |
| Child size at birth (n = 3066) |       |         |             |        |
| Smaller than average | 542   | 17.7    | 51.8        | 34.7   | 12.7   |
have significant independent association with child nutritional status. The magnitude of malnutrition observed in this study reinforced the need to take actions to improve the nutritional status of children in Pakistan. The most common form of malnutrition among the studied population (n = 3071) was stunting (44.4%) followed by underweight (29.4%) and wasting (10.7%).

In Pakistan, the prevalence of stunting in children < 5 years is very high (44%) as compared to other neighboring regional countries like Bangladesh (36%) and Nepal (35.8%) [15, 29]. The magnitude of stunting was only reduced by 5% when compared with the country’s previous demographic health survey conducted in 1990–1991 [30]. This showed that the prevalence of stunting in Pakistan remains consistently high over past 20 years. This study highlights both maternal and child factors, associated with stunting, that should be thoroughly investigated for implementing appropriate interventions to reduce the burden of stunting in Pakistan.

Table 3 Socio-demographic characteristics of Pakistani children in the age range of < 5 years (n = 3071) (Continued)

| Variables | Total | Stunted | Underweight | Wasted |
|-----------|-------|---------|-------------|--------|
| Maternal factors |       |         |             |        |
| Average | 2280 | 74.4 | 44.7 | 25.4 | 10.0 |
| Larger than average | 244 | 8.0 | 32.0 | 18.4 | 8.6 |
| Antenatal clinic visits (n = 1967) |       |         |             |        |
| None | 439 | 22.3 | 57.4 | 33.0 | 13.9 |
| 1–3 | 716 | 36.4 | 44.4 | 30.0 | 12.7 |
| 3+ | 812 | 41.3 | 33.1 | 20.0 | 10.8 |
| Recent diarrheal incidence (last two weeks) (n = 3076) |       |         |             |        |
| No | 2395 | 78.1 | 44.8 | 25.4 | 9.6 |
| Yes | 672 | 21.9 | 45.7 | 31.0 | 13.4 |
| Breastfeeding status (n = 3066) |       |         |             |        |
| Ever breastfeed | 2016 | 65.8 | 48.5 | 25.3 | 8.0 |
| Never breastfeed | 84 | 2.7 | 33.3 | 19.0 | 8.3 |
| Still breastfeeding | 966 | 31.5 | 38.6 | 29.8 | 15.4 |
| Age of Child (months) |       |         |             |        |
| 0 (< 12 months) | 580 | 18.9 | 25.0 | 24.0 | 15.2 |
| 1 (12-23 months) | 551 | 17.9 | 45.2 | 28.7 | 15.6 |
| 2 (24-35 months) | 652 | 21.2 | 54.3 | 28.5 | 8.1 |
| 3 (36-47 months) | 633 | 20.6 | 50.1 | 25.6 | 7.7 |
| 4 (48–59 months) | 655 | 21.3 | 48.1 | 26.1 | 6.6 |
| Region |       |         |             |        |
| Punjab | 1018 | 33.1 | 37.7 | 23.8 | 8.3 |
| Sindh | 704 | 22.9 | 55.1 | 40.1 | 12.9 |
| Khyber Pakhtunkhwa | 541 | 17.6 | 37.9 | 24.0 | 11.5 |
| Balochistan | 292 | 9.5 | 78.8 | 33.6 | 12.7 |
| Gilgit Baltistan | 301 | 9.8 | 41.5 | 12.0 | 7.0 |
| Islamabad capital territory (ICT) | 215 | 7.0 | 22.3 | 13.0 | 11.2 |

Our study showed that among the various factors related to stunting, household wealth index was most significantly associated. The odds of being stunted were substantially higher among children with lowest socio-economic background. This finding was in line with previous cross-sectional studies carried out in countries such as Bangladesh, Nepal and Peru [15, 16, 31]. Socio-economic status has an impact on household food security and subsequently the growth of children [19]. Children from poor households have limited access to food and health services, which makes them more susceptible to growth failures [19]. Therefore, policies which are focused on poverty alleviation and improving the nutritional status of poorer children (either through cash or food support program [32, 33]) are needed to address the under-five malnutrition issue in Pakistan.

Mother’s nutritional status is associated with child’s nutritional state [17]. The risk of wasting and underweight was higher in those children whose mothers’
Table 4: Univariate and multivariate analysis of Stunting (Height-for-age index)

| Variables                        | Model 0 (n = 3071) |          | Model 1 (n = 3046) |          | Model 2 (n = 1950) |          |
|----------------------------------|--------------------|----------|--------------------|----------|--------------------|----------|
|                                  | cOR (95% CI)       | p-value  | aOR (95% CI)       | p-value  | aOR (95% CI)       | p-value  |
| **Maternal factors**             |                    |          |                    |          |                    |          |
| Residence                        |                    |          |                    |          |                    |          |
| Urban                            | 1                  |          | 1                  |          | 1                  |          |
| Rural                            | 1.57 (1.25–1.96)   | < 0.01   | 0.70 (0.53–0.92)   | 0.01     | 0.67 (0.48–0.92)   | 0.01     |
| Mother's educational level       |                    |          |                    |          |                    |          |
| Higher                           | 1                  |          | 1                  |          | 1                  |          |
| Secondary                        | 1.28 (0.80–2.00)   | 0.28     | 0.98 (0.62–1.55)   | 0.94     | 0.93 (0.56–1.56)   | 0.80     |
| Primary                          | 3.21 (1.96–5.24)   | < 0.01   | 1.95 (1.15–3.28)   | 0.01     | 1.40 (0.79–2.50)   | 0.24     |
| No education                     | 4.66 (3.10–7.00)   | < 0.01   | 2.11 (1.29–3.43)   | < 0.01   | 1.59 (0.88–2.88)   | 0.12     |
| Wealth index                     |                    |          |                    |          |                    |          |
| Richest                          | 1                  |          | 1                  |          | 1                  |          |
| Richer                           | 2.01 (1.39–2.91)   | < 0.01   | 1.70 (1.14–2.52)   | < 0.01   | 1.23 (0.76–2.00)   | 0.41     |
| Middle                           | 2.22 (1.55–3.17)   | < 0.01   | 1.60 (1.02–2.53)   | 0.04     | 1.20 (0.66–2.17)   | 0.53     |
| Poorer                           | 4.16 (2.93–5.88)   | < 0.01   | 2.64 (1.59–4.39)   | < 0.01   | 1.72 (0.93–3.18)   | 0.08     |
| Poorest                          | 5.41 (3.91–7.48)   | < 0.01   | 3.22 (1.86–5.59)   | < 0.01   | 2.09 (1.05–4.14)   | 0.03     |
| Mother's employment status       |                    |          |                    |          |                    |          |
| Non-working                      | 1                  |          | 1                  |          | 1                  |          |
| Working                          | 1.45 (1.18–1.77)   | < 0.01   | 0.94 (0.77–1.16)   | 0.61     | 0.92 (0.73–1.16)   | 0.49     |
| Mother's age at marriage (years) |                    |          |                    |          |                    |          |
| <18                              | 1                  |          | 1                  |          | 1                  |          |
| ≥18                              | 0.52 (0.42–0.64)   | < 0.01   | 0.79 (0.63–0.99)   | 0.04     | 0.76 (0.59–0.99)   | 0.04     |
| Parity                           |                    |          |                    |          |                    |          |
| 1–4                              | 1                  |          | 1                  |          | 1                  |          |
| 5+                               | 1.40 (1.10–1.78)   | < 0.01   | 0.99 (0.76–1.29)   | 0.97     | 1.06 (0.78–1.45)   | 0.67     |
| Mother's access to information   |                    |          |                    |          |                    |          |
| No                               | 1                  |          | 1                  |          | 1                  |          |
| Yes                              | 0.53 (0.39–0.71)   | < 0.01   | 0.98 (0.66–1.45)   | 0.94     | 1.02 (0.68–1.53)   | 0.91     |
| Consanguineous marriage          |                    |          |                    |          |                    |          |
| No                               | 1                  |          | 1                  |          | 1                  |          |
| Yes                              | 1.64 (1.31–2.05)   | < 0.01   | 1.22 (0.96–1.54)   | 0.09     | 1.19 (0.91–1.55)   | 0.20     |
| Mother's height (cm)             |                    |          |                    |          |                    |          |
| Normal (≥145 cm)                 | 1                  |          | 1                  |          | 1                  |          |
| Short (<145 cm)                  | 3.05 (1.68–5.55)   | < 0.01   | 2.37 (1.34–4.23)   | < 0.01   | 1.91 (1.04–3.51)   | 0.03     |
| Mother's BMI (kg/m²)             |                    |          |                    |          |                    |          |
| Obese (≥30)                      | 1                  |          | 1                  |          | 1                  |          |
| Overweight (25.0–29.9)           | 1.17 (0.80–1.70)   | 0.41     | 1.11 (0.77–1.60)   | 0.56     | 1.36 (0.87–2.12)   | 0.17     |
| Normal (18.5–24.9)               | 1.67 (1.13–2.47)   | < 0.01   | 1.20 (0.81–1.77)   | 0.35     | 1.34 (0.87–2.06)   | 0.17     |
| Underweight (<18.5)              | 2.39 (1.47–3.88)   | < 0.01   | 1.42 (0.79–2.52)   | 0.23     | 1.72 (0.96–3.03)   | 0.06     |
| **Child Factors**                |                    |          |                    |          |                    |          |
| Sex of child                     |                    |          |                    |          |                    |          |
| Female                           | 1                  |          | 1                  |          | 1                  |          |
| Male                             | 1.28 (1.05–1.56)   | 0.01     | 1.47 (1.14–1.89)   | < 0.01   |
BMI were below normal (<18.5 kg/m²). Maternal height has been used as a marker to assess the intergenerational health linkages between a mother and her offspring. Previous evidence had shown several adverse health related consequences, including the nutritional outcomes, in children of mothers of low height (or short stature) [34, 35]. Thus, mother’s height can be used as predictor of child’s nutritional status [36]. In our study, children of short stature mothers (height = < 145 cm) were found more likely to be stunted and underweight. These findings of the effect of mothers’ anthropometry (BMI and low height) on children were in accordance with previous studies [17, 34, 37, 38]. Since mother’s nutritional and health status has critical importance in early child growth and development [39], mother’s nutritional status should be considered when making policies for reducing the child malnutrition. Emphasis on reproductive health of adolescent females is now being considered very important in developing countries, particularly for the outcome of improved nutrition of children < 5 years of age [39, 40]. There have been efforts in the past to address nutritional issues among young girls, pregnant and lactating women in country with different nutrition programs such as “Tawana Pakistan Project” [40]. However, the female adolescent nutrition in Pakistan is very recent and needs a greater focus.

Our analysis showed that children of mothers with no formal education were more prone to be acutely malnourished (wasted and underweight) as compared to children of educated mothers. The association found in this study between maternal education, wasting and underweight in children is consistent with several previous studies [19, 41, 42]. Educated mothers are well informed about the nutritional and health needs of their children and hence prefer to use better hygiene and sanitation facilities. Moreover, they make comparative choices of available health services over traditional practices for improved healthcare of their children [24].

Early marriage (before 18 years) increased the risk of child stunting and underweight. Young women are at an age when they still need to provide for their own growth and developmental needs. Pregnancy in such women

### Table 4 Univariate and multivariate analysis of Stunting (Height-for-age index) (Continued)

| Variables                      | Model 0 (n = 3071) |          | Model 1 (n = 3046) |          | Model 2 (n = 1950) |          |
|--------------------------------|--------------------|----------|--------------------|----------|--------------------|----------|
|                                | cOR (95% CI)       | p-value  | aOR (95% CI)       | p-value  | aOR (95% CI)       | p-value  |
| Age of Child (months)          |                    |          |                    |          |                    |          |
| 0 (< 12)                       | 1                   |          | 2.56 (1.67–3.91)   | < 0.01   |                    |          |
| 1 (12–23)                      | 2.33 (1.62–3.37)    | < 0.01   |                    |          |                    |          |
| 2 (24–35)                      | 2.92 (2.17–3.93)    | < 0.01   |                    |          |                    |          |
| 3 (36–47)                      | 2.42 (1.76–3.32)    | < 0.01   |                    |          |                    |          |
| 4 (48–59)                      | 2.13 (1.54–2.95)    | < 0.01   |                    |          |                    |          |
| Child size at birth            |                    |          |                    |          |                    |          |
| Average                        | 1                   |          | 1.48 (1.02–2.16)   | 0.03     |                    |          |
| Smaller than average           | 1.56 (1.21–2.01)    | < 0.01   |                    |          |                    |          |
| Larger than average            | 0.54 (0.34–0.86)    | 0.01     |                    |          |                    |          |
| Antenatal clinic visits        |                    |          |                    |          |                    |          |
| None                           | 1                   |          | 0.68 (0.45–1.00)   | 0.05     |                    |          |
| 1–3                            | 0.57 (0.39–0.84)    | < 0.01   |                    |          |                    |          |
| 3+                             | 0.35 (0.24–0.51)    | < 0.01   |                    |          |                    |          |
| Recent diarrheal incidence     |                    |          |                    |          |                    |          |
| No                             | 1                   |          | 1.06 (0.79–1.40)   | 0.67     |                    |          |
| Yes                            | 1.14 (0.90–1.45)    | 0.26     |                    |          |                    |          |
| Breastfeeding status           |                    |          |                    |          |                    |          |
| Never breastfed                | 1                   |          |                    |          |                    |          |
| Ever breastfed                 | 1.49 (0.72–3.05)    | 0.27     |                    |          |                    |          |
| Still breastfeeding            | 1.19 (0.58–2.45)    | 0.62     |                    |          |                    |          |

Model 0 = Univariate Analysis (cOR: Crude Odds Ratio)  
Model 1 = Adjusted with Residence, mother’s education level, wealth index, mother’s employment status, mother’s age at marriage, parity, mother’s access to information, consanguineous marriage, mother’s height and mother’s BMI (aOR: Adjusted Odds Ratio)  
Model 2 = Model 1 + Sex of child, age of child, child’s size at birth, antenatal clinic visits, recent diarrheal incidence, and breastfeeding status (aOR: Adjusted Odds Ratio)
### Table 5 Univariate and multivariate analysis of Underweight (Weight-for-age index)

| Variables                        | Model 0 (n = 3071) |       | Model 1 (n = 3046) |       | Model 2 (n = 1950) |       |
|----------------------------------|--------------------|-------|--------------------|-------|--------------------|-------|
|                                  | cOR (95% CI)       | p-value | aOR (95% CI)       | p-value | aOR (95% CI)       | p-value |
| **Maternal factors**             |                    |        |                    |        |                    |        |
| Residence                        |                    |        |                    |        |                    |        |
| Urban                            | 1                  |        | 1                  |        | 1                  |        |
| Rural                            | 1.52 (1.17–1.97)   | < 0.01 | 0.69 (0.49–0.99)   | 0.04   | 0.80 (0.56–1.16)   | 0.25   |
| Mother's educational level        |                    |        |                    |        |                    |        |
| Higher                           | 1                  |        | 1                  |        | 1                  |        |
| Secondary                        | 1.64 (0.96–2.80)   | 0.06   | 1.43 (0.81–2.50)   | 0.21   | 1.24 (0.66–2.34)   | 0.51   |
| Primary                          | 3.42 (1.82–6.40)   | < 0.01 | 2.59 (1.26–5.31)   | < 0.01 | 1.75 (0.84–3.72)   | 0.14   |
| No education                     | 5.55 (3.51–8.77)   | < 0.01 | 3.18 (1.76–5.74)   | < 0.01 | 2.55 (1.26–5.17)   | < 0.01 |
| Wealth index                     |                    |        |                    |        |                    |        |
| Richest                          | 1                  |        | 1                  |        | 1                  |        |
| Richer                           | 1.57 (0.99–2.49)   | 0.05   | 1.18 (0.74–1.87)   | 0.49   | 0.86 (0.52–1.43)   | 0.57   |
| Middle                           | 1.90 (1.26–2.87)   | < 0.01 | 1.14 (0.68–1.90)   | 0.61   | 0.97 (0.56–1.71)   | 0.93   |
| Poorer                           | 2.80 (1.95–4.03)   | < 0.01 | 1.45 (0.86–2.51)   | 0.17   | 1.14 (0.63–2.05)   | 0.65   |
| Poorest                          | 5.01 (3.47–7.22)   | < 0.01 | 2.41 (1.32–4.39)   | < 0.01 | 1.78 (0.95–3.34)   | 0.06   |
| Mother's employment status       |                    |        |                    |        |                    |        |
| Non-working                      | 1                  |        | 1                  |        | 1                  |        |
| Working                          | 1.38 (1.04–1.81)   | 0.02   | 0.87 (0.66–1.15)   | 0.33   | 0.96 (0.67–1.38)   | 0.85   |
| Mother's age at marriage (years) |                    |        |                    |        |                    |        |
| <18                              | 1                  |        | 1                  |        | 1                  |        |
| ≥18                              | 0.52 (0.40–0.66)   | < 0.01 | 0.76 (0.61–0.96)   | 0.02   | 0.78 (0.57–1.04)   | 0.09   |
| Parity                           |                    |        |                    |        |                    |        |
| 1–4                              | 1                  |        | 1                  |        | 1                  |        |
| 5+                               | 0.96 (0.76–1.20)   | 0.73   | 0.68 (0.51–0.88)   | < 0.01 | 0.73 (0.50–1.05)   | 0.09   |
| Mother's access to information   |                    |        |                    |        |                    |        |
| No                               | 1                  |        | 1                  |        | 1                  |        |
| Yes                              | 0.55 (0.41–0.71)   | < 0.01 | 0.94 (0.69–1.29)   | 0.73   | 0.94 (0.65–1.36)   | 0.75   |
| Consanguineous marriage          |                    |        |                    |        |                    |        |
| No                               | 1                  |        | 1                  |        | 1                  |        |
| Yes                              | 1.74 (1.36–2.23)   | < 0.01 | 1.27 (0.99–1.63)   | 0.05   | 1.14 (0.86–1.50)   | 0.34   |
| Mother's height (cm)             |                    |        |                    |        |                    |        |
| Normal (≥145 cm)                 | 1                  |        | 1                  |        | 1                  |        |
| Short (<145 cm)                  | 2.87 (1.69–4.89)   | < 0.01 | 2.42 (1.48–3.92)   | < 0.01 | 2.31 (1.34–3.98)   | < 0.01 |
| Mother's BMI (kg/m²)             |                    |        |                    |        |                    |        |
| Obese (≥30)                      | 1                  |        | 1                  |        | 1                  |        |
| Overweight (25.0–29.9)           | 0.87 (0.57–1.33)   | 0.53   | 0.82 (0.51–1.31)   | 0.41   | 0.79 (0.45–1.36)   | 0.39   |
| Normal (18.5–24.9)               | 1.94 (1.25–3.01)   | < 0.01 | 1.44 (0.89–2.33)   | 0.13   | 1.30 (0.76–2.22)   | 0.33   |
| Underweight (<18.5)              | 3.40 (2.19–5.26)   | < 0.01 | 2.04 (1.19–3.51)   | < 0.01 | 1.78 (1.00–3.17)   | 0.04   |
| **Child Factors**                |                    |        |                    |        |                    |        |
| Sex of child                     |                    |        |                    |        |                    |        |
| Female                           | 1                  |        | 1                  |        | 1                  |        |
| Male                             | 1.30 (1.03–1.63)   | 0.02   | 1.24 (0.94–1.63)   | 0.12   |
increases the drain of their already low reserve of nutrients and thus increases the probability of delivering low birth weight infants [43]. These mothers are also at risk to inadequately breastfeed their infants due to low milk supply which results in undernourished children [43, 44]. However, future studies and large scale national surveys may be needed to record the age of the first pregnancy, a more important factor than age of marriage, to investigate relationships between mother’s age and child nutritional status.

In our study several maternal factors are found to be associated with child malnutrition (such as mother’s age at marriage, education and nutritional status). These findings indicate that nutrition intervention programs should, therefore, encompass maternal socio-demographic factors for the betterment of nutritional status of children, below the age of five years, in Pakistan. Additionally, there is a need for national nutritional policy, focused on improving both the maternal nutritional status (through adequate food and micronutrients supplementation) and the better care for infants and young children [45].

Our study found that children who lived in urban areas of Pakistan were more vulnerable to become stunted. These results are consistent with the previous regional studies carried out in Bangladesh and Iran [15, 46]. On the contrary, several studies conducted in developing countries (such as Nepal, Bangladesh, Malawi and Nigeria etc.) have identified that children settled in rural areas, are at higher risk to be malnourished [47, 48]. In Pakistan, the high trend of stunting in urban areas may be due to the rapid urbanization of people migrating from rural areas for work and better living conditions. The increased incidence of stunting in urban areas may be due to the dietary choices and lifestyle of urban population [49].

Table 5 Univariate and multivariate analysis of Underweight (Weight-for-age index) (Continued)

| Variables                          | Model 0 (n = 3071) | Model 1 (n = 3046) | Model 2 (n = 1950) |
|------------------------------------|--------------------|--------------------|--------------------|
|                                    | cOR (95% CI)       | p-value            | aOR (95% CI)       | p-value            | aOR (95% CI)       | p-value |
| Age of Child (months)              |                    |                    |                    |
| 0 (< 12)                           | 1.00               |                     | 1.00               |                     | 1.00               |                     |
| 1 (12–23)                          | 1.12 (0.77–1.64)   | 0.54               | 1.31 (0.88–1.94)   | 0.17               |                     |                     |
| 2 (24–35)                          | 0.98 (0.72–1.33)   | 0.91               | 1.18 (0.70–1.96)   | 0.52               |                     |                     |
| 3 (36–47)                          | 0.96 (0.67–1.39)   | 0.86               | 1.69 (0.89–3.21)   | 0.10               |                     |                     |
| 4 (48–59)                          | 0.89 (0.62–1.28)   | 0.54               | 1.65 (0.80–3.35)   | 0.17               |                     |                     |
| Child size at birth                |                    |                    |                    |
| Average                            | 1.00               |                     | 1.00               |                     | 1.00               |                     |
| Smaller than average               | 1.69 (1.28–2.21)   | < 0.01             | 1.67 (1.14–2.45)   | < 0.01             |                     |                     |
| Larger than average                | 0.66 (0.41–1.06)   | 0.09               | 0.97 (0.53–1.76)   | 0.94               |                     |                     |
| Antenatal clinic visits            |                    |                    |                    |
| None                               | 1.00               |                     | 1.03 (0.70–1.51)   | 0.78               |                     |                     |
| 1–3                                | 0.81 (0.56–1.17)   | 0.26               | 0.46 (0.30–0.71)   | < 0.01             |                     |                     |
| 3+                                 | 0.46 (0.30–0.71)   | < 0.01             | 0.91 (0.57–1.46)   | 0.72               |                     |                     |
| Recent diarrheal incidence         |                    |                    |                    |
| No                                 | 1.27 (0.99–1.62)   | 0.05               | 1.15 (0.85–1.55)   | 0.29               |                     |                     |
| Yes                                | 1.51 (0.63–3.59)   | 0.35               | 1.03 (0.43–2.46)   | 0.94               |                     |                     |
| Breastfeeding status               |                    |                    |                    |
| Never breastfed                    | 2.08 (0.88–4.88)   | 0.09               | 1.71 (0.72–4.05)   | 0.22               |                     |                     |
| Ever breastfed                     | 1.51 (0.63–3.59)   | 0.35               | 1.03 (0.43–2.46)   | 0.94               |                     |                     |
| Still breastfeeding                | 2.08 (0.88–4.88)   | 0.09               | 1.71 (0.72–4.05)   | 0.22               |                     |                     |

Model 0 = Univariate Analysis (COR: Crude Odds Ratio)
Model 1 = Adjusted with Residence, mother’s education level, wealth index, mother’s employment status, mother’s age at marriage, parity, mother’s access to information, consanguineous marriage, mother’s height and mother’s BMI (aOR: Adjusted Odds Ratio)
Model 2 = Model 1 + Sex of child, Age of child, child’s size at birth, antenatal clinic visits, recent diarrheal incidence, and breastfeeding status (aOR: Adjusted Odds Ratio)
Table 6 Univariate and multivariate analysis of Wasting (Weight-for-height index)

| Variables | Model 0 (n = 2863) | Model 1 (n = 2840) | Model 2 (n = 1810) |
|-----------|-------------------|--------------------|--------------------|
|           | cOR (95% CI)      | p-value            | aOR (95% CI)       | p-value            | aOR (95% CI)       | p-value            |
| Maternal factors |                   |                    |                    |                    |                    |                    |
| Residence |                   |                    |                    |                    |                    |                    |
| Urban    | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Rural    | 1.13 (0.75–1.72)  | 0.54               | 0.70 (0.42–1.14)   | 0.15               | 0.85 (0.49–1.46)   | 0.55               |
| Mother’s educational level |                   |                    |                    |                    |                    |                    |
| Higher   | 1.31 (0.56–3.15)  | 0.54               | 1.25 (0.52–3.27)   | 0.62               | 2.14 (0.87–5.85)   | 0.09               |
| Secondary | 1.55 (0.76–3.25)  | 0.23               | 1.55 (0.69–3.44)   | 0.28               | 2.41 (0.89–7.15)   | 0.07               |
| Primary  | 1.55 (0.76–3.25)  | 0.23               | 1.55 (0.69–3.44)   | 0.28               | 2.41 (0.89–7.15)   | 0.07               |
| No education | 2.46 (1.15–5.28) | 0.02               | 1.87 (0.82–4.21)   | 0.13               | 3.61 (1.33–9.82)   | < 0.01             |
| Wealth index |                   |                    |                    |                    |                    |                    |
| Richest  | 0.95 (0.60–1.56)  | 0.83               | 0.82 (0.45–1.49)   | 0.52               | 0.73 (0.34–1.58)   | 0.43               |
| Richer   | 1.15 (0.70–1.98)  | 0.59               | 0.90 (0.44–1.84)   | 0.78               | 0.82 (0.35–1.93)   | 0.66               |
| Middle   | 1.21 (0.69–2.10)  | 0.49               | 0.87 (0.39–1.92)   | 0.73               | 0.72 (0.27–1.88)   | 0.50               |
| Poorer   | 2.36 (1.40–3.98)  | < 0.01             | 1.69 (0.78–3.66)   | 0.18               | 1.65 (0.62–4.16)   | 0.32               |
| Poorest  | 1.79 (0.78–4.21)  | 0.13               | 1.03 (0.74–1.45)   | 0.85               | 0.93 (0.58–1.42)   | 0.69               |
| Mother’s employment status (n = 3064) |                   |                    |                    |                    |                    |                    |
| Non-working | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Working  | 0.94 (0.61–1.50)  | 0.81               | 0.66 (0.49–0.99)   | 0.04               | 0.72 (0.43–1.23)   | 0.24               |
| Mother’s age at marriage (years) |                   |                    |                    |                    |                    |                    |
| <18      | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| ≥18     | 0.77 (0.52–1.14)  | 0.19               | 1.03 (0.74–1.45)   | 0.85               | 0.93 (0.58–1.42)   | 0.69               |
| Parity   |                   |                    |                    |                    |                    |                    |
| 1–4     | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| S+      | 1.07 (0.78–1.45)  | 0.68               | 0.96 (0.66–1.41)   | 0.85               | 1.10 (0.66–1.83)   | 0.67               |
| Mother’s access to information |                   |                    |                    |                    |                    |                    |
| No       | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Yes     | 0.58 (0.40–0.83)  | < 0.01             | 0.78 (0.55–1.09)   | 0.14               | 0.94 (0.67–1.34)   | 0.76               |
| Consanguineous marriage |                   |                    |                    |                    |                    |                    |
| No       | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Yes     | 1.20 (0.84–1.71)  | 0.31               | 1.01 (0.71–1.41)   | 0.95               | 0.96 (0.65–1.41)   | 0.83               |
| Mother’s height (cm) |                   |                    |                    |                    |                    |                    |
| Normal (≥ 145 cm) | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Short (< 145 cm) | 1.46 (0.74–2.76) | 0.24               | 1.30 (0.68–2.51)   | 0.42               | 1.29 (0.54–3.04)   | 0.55               |
| Mother’s BMI (kg/m²) |                   |                    |                    |                    |                    |                    |
| Obese (≥30) | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Overweight (25.0–29.9) | 1.08 (0.50–2.25) | 0.82               | 1.05 (0.48–2.28)   | 0.89               | 1.27 (0.51–3.15)   | 0.60               |
| Normal (18.5–24.9) | 1.85 (0.94–3.64) | 0.07               | 1.61 (0.83–3.11)   | 0.15               | 1.77 (0.74–4.06)   | 0.19               |
| Underweight (<18.5) | 2.85 (1.43–5.68) | < 0.01             | 2.39 (1.17–4.87)   | 0.01               | 2.79 (1.15–6.73)   | 0.02               |
| Child Factors |                   |                    |                    |                    |                    |                    |
| Sex of child |                   |                    |                    |                    |                    |                    |
| Female  | 1                 | 1                  | 1                  | 1                  | 1                  | 1                  |
| Male   | 1.15 (0.84–1.56)  | 0.38               | 1.25 (0.87–1.79)   | 0.21               |
may lead to increased susceptibility to stunting among male children. Our study also found that the odds of stunting significantly increased with child’s age. Children within the age group of 12–59 months were more likely to be stunted compared to younger children (less than 12 months). Similar findings were also reported by other studies conducted in different parts of the world [16, 51]. The increase in child stunting with age, stresses the need of proper and timely initiation of supplementary feeding to meet the growing nutritional requirements of the children. Additionally, the risk of wasting was significantly lower in children > 23 months as compared to children < 12 months. This data is consistent with previous findings that showed a decrease in wasting with child’s age and thus, may be associated with the inclusion of other food items along with breast milk in children’s diet after 6 months of age (15,17).

Among the study population, children whose mother visited antenatal clinics more frequently were less likely to have chronic malnutrition (stunting). Antenatal visits are considered to be an indicator of access to health care services and maternal health seeking behavior. This may have indirect influence on child’s health both in the short and long term [52]. Previous studies have also showed that access to health services are positively correlated with child’s nutritional status [46, 53]. This finding has important policy implications associated with access to either free or at least affordable health services to help in reducing the burden of childhood malnutrition. Additionally, in Pakistan, there is a need to increase the availability of quality primary health care facilities in order to improve the child health status [54].

Perceived child size at birth significantly determined the nutritional status of the child [55], as low birth weight is considered to be an indicator of restricted intrauterine growth [56]. Our study found that children born with smaller than the average birth weight were more likely to be underweight, whereas those born with larger than average weight were less likely to be stunted. These findings were consistent with previous studies which showed that low birth weight

| Variables                      | Model 0 (n = 2863) | Model 1 (n = 2840) | Model 2 (n = 1810) |
|-------------------------------|-------------------|--------------------|--------------------|
|                               | cOR (95% CI) | p-value | aOR (95% CI) | p-value | aOR (95% CI) | p-value |
| Age of Child (months)          |                  |               |                  |               |                  |               |
| 0 (< 12)                      | 1                 |               | 1                 |               | 1                 |               |
| 1 (12–23)                     | 0.85 (0.57–1.25) | 0.41            | 0.82 (0.52–1.30) | 0.41            | 0.26 (0.12–0.59) | < 0.01            |
| 2 (24–35)                     | 0.35 (0.23–0.54) | < 0.01          | 0.50 (0.18–1.41) | 0.19            | 0.26 (0.12–0.59) | < 0.01            |
| 3 (36–47)                     | 0.46 (0.23–0.98) | 0.04            | 0.50 (0.18–1.41) | 0.19            | 0.50 (0.18–1.41) | 0.19            |
| 4 (48–59)                     | 0.23 (0.13–0.41) | < 0.01          | 0.25 (0.09–0.74) | 0.01            | 0.25 (0.09–0.74) | 0.01            |
| Child size at birth           |                  |               |                  |               |                  |               |
| Average                       | 1                 |               | 1                 |               | 1                 |               |
| Small                         | 1.35 (0.89–2.03) | 0.14            | 1.24 (0.78–1.96) | 0.36            | 0.78 (0.42–1.48) | 0.59            |
| Large                         | 0.66 (0.34–1.32) | 0.25            | 0.78 (0.32–1.89) | 0.59            | 0.78 (0.32–1.89) | 0.59            |
| Antenatal clinic visits        |                  |               |                  |               |                  |               |
| None                          | 1                 |               | 1                 |               | 1                 |               |
| 1–3                           | 0.67 (0.39–1.14) | 0.14            | 0.74 (0.46–1.16) | 0.19            | 0.74 (0.46–1.16) | 0.19            |
| 3+                            | 0.60 (0.29–1.17) | 0.13            | 0.92 (0.51–1.67) | 0.80            | 0.92 (0.51–1.67) | 0.80            |
| Recent diarrheal incidence    |                  |               |                  |               |                  |               |
| No                            | 1                 |               | 1                 |               | 1                 |               |
| Yes                           | 1.43 (1.02–1.98) | 0.03            | 1.11 (0.74–1.64) | 0.61            | 1.11 (0.74–1.64) | 0.61            |
| Breastfeeding status          |                  |               |                  |               |                  |               |
| Never breastfed               | 1                 |               | 1                 |               | 1                 |               |
| Ever breastfed                | 1.14 (0.36–3.78) | 0.82            | 1.16 (0.32–3.87) | 0.85            | 1.16 (0.32–3.87) | 0.85            |
| Still breastfeeding           | 2.42 (0.77–7.56) | 0.12            | 1.25 (0.19–9.22) | 0.64            | 1.25 (0.19–9.22) | 0.64            |

Model 0 = Univariate Analysis (cOR: Crude Odds Ratio)
Model 1 = Adjusted with Residence, mother’s education level, wealth index, mother’s employment status, mother’s age at marriage, parity, mother’s access to information, consanguineous marriage, mother’s height and mother’s BMI (aOR: Adjusted Odds Ratio)
Model 2 = Model 1 + Sex of child, age of child, child’s size at birth, antenatal clinic visits, recent diarrheal incidence, and breastfeeding status (aOR: Adjusted Odds Ratio)
infants have significantly higher odds of being stunted and underweight later in life due to inadequate fetal nutrition [57–59].

The strengths of our study includes the use of nutritional data from the most recent population based representative survey (PDHS-2012-13) to assess the malnutrition in Pakistani children aged 0–59 months. Furthermore, the survey had a large sample size and high response rate (93%). The study also had certain limitations including the study design which was cross-sectional and hence, difficult to establish causal relationships between different variables. Moreover, micronutrient consumption and other dietary factors directly related to the nutritional status of children were not available.

**Conclusion**

In conclusion, our study found that both maternal and child related factors are associated with malnutrition in Pakistani children and most of them are preventable. In order to reduce the burden of early malnutrition in the country, strategies which are focused on poverty eradication, improvement of both mother’s educational and nutritional level and accessibility to basic health care facilities are needed. Furthermore, interventions that can address these factors are required such as community based education and targeted nutritional interventions.

**Abbreviations**

AJK: Azad Jammu and Kashmir; aOR: Adjusted odds ratio; BMI: Body mass index; CI: Confidence intervals; cOR: Crude odds ratio; DHS: Demographic and Health Surveys; FATA: Federally Administered Tribal Areas; ICT: Islamabad Capital Territory; NIPS: National Institute of Population Studies; PDHS: Pakistan Demographic and Health Survey; SD: Standard deviation; USAID: United States Agency for International Development (USAID); WHO: World Health Organization

**Acknowledgements**

The authors would like to thank Dow University of Health Sciences (DUHS) for all the support and assistance to conduct this study.

**Funding**

No funding was obtained for this study.

**Availability of data and materials**

Dataset used in this study is publically available from MEASURE DHS website and dataset modified for use in this paper are available upon reasonable request to the corresponding author.

**Authors’ contributions**

SK conceived the idea, drafted the manuscript and interpreted the results. SZ performed statistical analysis and help in results interpretation and writing. NFS critically reviewed the manuscript. All authors read and approved final manuscript.

**Ethics approval and consent to participate**

The PDHS 2012–2013 has taken into account the standard ethical guidelines of the measure DHS program. The authors have obtained the data from MEASURE DHS website (URL: https://www.dhsprogram.com/data/available-datasets.cfm) following their data obtaining procedure. However, no formal ethical clearance was obtained because the study involved secondary analysis of publically available data.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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Received: 22 October 2018 Accepted: 20 March 2019 Published online: 01 April 2019

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