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Prevalence and factors associated with underweight children: a population-based subnational analysis from Pakistan

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ABSTRACT

Objectives This study aims to determine the prevalence of and factors associated with underweight children under the age of 5 in Punjab, Pakistan.

Design We analysed cross-sectional household-level subnationally representative Multiple Indicator Cluster Survey.

Settings Punjab province, Pakistan.

Participants 24 042 children under 5 years of age.

Data analysis Multilevel multivariate logistic regression analysis.

Results Prevalence of moderately and severely underweight children was found to be (33.3% and 11.3%, respectively). Multivariate multilevel logistic regression results show that as the child grows older the likelihood of the child being underweight increases significantly (eg, children between 12 and 23 months are one and half times more likely to be underweight, whereas children between the ages of 36 and 47 months are two and a half times more likely to be underweight). Gender was found to be another significant factor contributing to underweight prevalence among children under the age of 5. The likelihood of a girl child being underweight is more than that of a boy child being underweight (OR 0.92, 95% CI 0.8 to 1.0). Similarly, a child whose birth order is three or more is two times more likely to be underweight (OR 1.96, 95% CI 1.5 to 2.5) relative to a child of a lower birth order. Moreover, diarrhoea also significantly increases the likelihood of the child being underweight (OR 1.31, 95% CI 1.1 to 1.5). Child size is another determinant for underweight prevalence among children under 5, for example, a child with a size smaller than average at the time of birth is 2.7 times more likely to be moderately underweight than a child with an average or larger than average size at the time of birth.

Conclusion Rigorous community-based interventions should be developed and executed throughout the province to improve this grave situation of underweight prevalence in Punjab. Mother's education should be uplifted by providing them formal education and providing awareness about the importance of proper nutrition for children.

Strengths and limitations of this study

- This study employed a multilevel modelling approach to exploit the household-level and community-level variation which is helpful to formulate better policies.
- Multilevel regression helps in exploring the variation at various levels of hierarchy which is important from a policy prescription perspective.
- A unique aspect of this study is that Multiple Indicator Cluster Survey (Punjab 2014) data provide very rich information at household, community, district and administrative division level that naturally suits employing hierarchical modelling approach.
- Due to the cross-sectional nature of the data, causality cannot be inferred and results cannot be generalised to the national level.

INTRODUCTION

With at least 29% of the children under the age of 5 being underweight in South Asia, the region bears an unfair burden of undernutrition.[1] National Nutrition Survey 2011 shows that 31% children under 5 years of age are underweight,[2] while a recent study in Pakistan reported that the current prevalence of underweight children in the country lies at 29%.[3] This ratio of underweight children in Pakistan is quite high. It is estimated that one out of every three children under the age of 5 is found to be underweight in Punjab, Pakistan. Punjab province, which is the largest province of Pakistan, has an underweight prevalence which ranges from 33.7% (moderate) to 11.3% (severe). This ratio has seen an increase since 2011 when the underweight prevalence among children in the province ranged from 32.6% (moderate) to 11.2% (severe).[4] Consequently, while there has been a decrease in prevalence of underweight in Pakistan over time, the prevalence of underweight children in Punjab province is increasing. This increase in underweight prevalence in one of the largest provinces of the country by population, Gross Domestic Product (GDP) and employment contribution presents a daunting challenge towards achieving the sustainable development goals

(SDGs) of ending poverty and hunger by 2030. The reported high prevalence of underweight children in Pakistan remains a big concern for policy makers,[5] and, thus, requires urgent interventions by the state and the provincial government.[6] Therefore, it is of critical importance that the factors associated with high prevalence of underweight children in Punjab province of Pakistan are fully understood.

Undernutrition has become a major public health concern, especially in developing countries. This prevalent threat affects around 165 million children under the age of 5 every year and causes 13 million deaths globally during the same period.[7 8] Almost half of these deaths caused by undernutrition among children have been reported in Asia alone.[9] Proper diet is an important determinant which leads to normal growth in children, thus proper attention needs to be given to the food, environment, health and hygiene of children.[10 11]

There are many contributing factors which lead to being underweight in children. These include low birth weight of children, poor exclusive breast feeding, discouraged complementary diet, dietary diversity, parent's education, lack of nutrition knowledge, family planning, income status, limited access to adequate food and poor immunisation status.[7 12–14] In addition to these, personal hygiene and sanitation can also help reduce underweight children. These changes would result in a decrease in child mortality by 14%–31%.[14] The effect of child malnutrition is very harmful and leads to low physical and cognitive development during childhood and affects educational accomplishment, health status and performance in labour market outcomes during adulthood, while also resulting in 15% of the total disability.[10 15] Thus far, there is limited research evidence available to explore the determinants of undernutrition (underweight) in Pakistan. The studies that have previously been conducted are mostly based on either specific health facilities,[16 17] small sample size[18] or specific regions with limited covariates[19 20]; however, no single research has employed a multilevel model to unravel variations at different levels of hierarchy within the data which can help explain the dynamics and, hence, provide robust results for sound policy formulation and interventions. This analysis investigates the association of being underweight as a dependent variable and maternal and child level characters, socioeconomic, demographic and regional factors. Therefore, the aim of this study is to identify possible interventions and indicator-specific programming that can help address the gap and decrease the incidence of underweight children in Pakistan.

METHODS

Participants and study settings

The Multiple Indicator Cluster Survey (MICS) is an international household survey programme developed by the United Nations Children's Fund (Unicef). In Punjab, between June and September 2014, MICS collected household-level data to analyse the health of women and children, while also employing anthropometric (nutrition) measures and education measures among other key indicators. The two-stage stratified cluster sampling MICS data covered rural and urban areas of all 9 divisions and 36 districts of the province. Enumeration Blocks (EB) in urban areas and villages in rural areas were the primary sampling units (PSU). Households were considered as secondary sampling units, and from each PSU, 20 households were selected with a random start. The total sample consisted of 41 000 households with a response rate of 98%.[4]

Variables

Dependent variable in this analysis is underweight. Underweight is moderate if the weight-for-age z-score of a child under 5 years of age is less than −2 SD from WHO reference growth standards, and it is severe if z-score is less than −3 SD.[21]

Independent variables in this study include age of child in months and is categorised into 0–5 months, 6–11 months, 12–23 months, 24–35 months, 36–47 months and 48–59 months. The first year of the child is divided into two categories as during the first 6 months, the child is either exclusively breast fed or has a strictly milk only diet, whereas between 6 and 12 months, solid food is also included in his/her diet. Birth order of the child is a variable which adds a rank to the number of children born to women of ages 15–49, and is categorised as first born, second born and third or those born after that under 5 years of age. Gender of the child is characterised as either boy or girl. Size of child at birth is divided into three categories: large, average and small. Diarrhoea, that is, whether a child had diarrhea in the last two weeks (15 days), is included as a binary variable (Yes=1; 0 otherwise). Breastfeeding is a binary variable, that is, if a child has ever been breast fed (Yes=1) and (No=0). Mother and father's education is categorised as no education (less than 1 year), primary (1–5 years completed), middle (6–8 years of education completed), secondary (9–10 years of education completed) and higher (11+ years of education completed, including professional or university degrees). Mother's age is a categorical variable: less than 18 years, 18–24 years, 25–35 years and 36+ years. Postnatal care is included as a proxy, that is, whether a female health worker visited the household in the past 3 months, and it is included as a binary variable. This variable captures the knowledge and information exchange that is positively associated with child health outcomes. Antenatal care visits (ANC visits) include the number of times a woman received antenatal care during pregnancy and are coded as up to four times as recommended by WHO and 4+ times. Place of delivery, that is, where a woman gives birth to her child, is coded as home delivery if birth occurred at her own home or at another home and institutional delivery if the delivery occurred at either a public or a private hospital or maternity care or basic/primary healthcare centre. Mothers who smoke and gender of parents are also included in the analysis. Household size includes number of household members in a household and is categorised into 3–4 household members, 5–6 household members (which is the average size of a family in Punjab), 7–8 household members

and more than 8 household members (to capture the effect of a very large family on child health outcomes). Community-level variables include ethnicity, place of residence, sanitation facilities, water facilities and water treatment. Ethnicity is determined according to the head of household's mother tongue and is categorised into Urdu, Punjabi, Saraiki and Others. Place of residence is a binary variable and is coded as urban=1 and rural=0. Sanitation facility is determined according to whether the household has access to a toilet facility. It has been divided into two categories based on the WHO definition,[22] that is, improved sanitation facility, which includes sewer connections, septic system connection, pour flush latrines, ventilated improved pit latrines and pit latrines with a slab or covered pit, and unimproved sanitation facility, which includes spit latrines without slabs or platforms or open pit hanging latrines bucket latrines, open defecation in fields, forests and/or bushes. Water treatment is determined by whether the household treats water to make it safe for drinking and is included as a binary variable coded as treated=1 and untreated=0. It is also imperative to note here, for the purpose of analysis, that Punjab province is divided into nine administrative divisions (The division is subdivided into many small administrative districts. In total, there are 36 districts in 9 divisions): Rawalpindi, Bahawalpur, D.G. Khan, Faisalabad, Gujranwala, Lahore, Multan, Sahiwal and Sargodha.

Data analysis

As MICS is a clustered hierarchical household-level data set, thus, to effectively understand the complexities associated with the groups' variability and the effect of group level characteristics on individuals, it is necessary to employ the multilevel modelling approach for the analysis.[23–27] We used a three-level random intercept multilevel hierarchical model, using MICS 2014 data which consists of 24 042 children under the age of 5, for Punjab province of Pakistan. The analysis has been conducted by associating weights to each household. Numerous methodologies have been used in the literature to interpret variance components at each level of multilevel models. For this analysis, we are using two important approaches. These include variance partition coefficients (VPCs) and intraclass correlation coefficients (ICCs). VPC presents the proportion of the outcome variable variance that lies at each level of the model hierarchy. ICC measures the expected degree of similarity between responses within a specific level. This study is based on an analysis of cross-sectional data, available freely and publicly with all identifier information removed. Thus, for this data set, ethics approval was not required.

Patient and public involvement

This study did not involve patients or human subjects directly. The results of the analysis were exclusively based on the data from MICS Punjab, Pakistan.

RESULTS

Data was compiled for 24 042 children under 5 years of age living in Punjab province of Pakistan. Table 1 demonstrates the demographic characteristics and factors associated with severe and moderate underweight in Punjab. The χ^2 test for association of dependent variable, that is, underweight prevalence (moderate and severe), was assessed. All independent variables and corresponding p values are reported in table 1 (p value<0.05). Prevalence of underweight was 33.3% as per the standard criteria of less than −2 SD (<-2 SD) between the reference median weight for age, and 11.25% were found to be severely underweight (<-3 SD). Fifty-one perc ent of the study participants were boys, whereas one-third of the children were under 2 years of age at the time of the study. Majority (64%) of the participants were of Punjabi ethnicity and one-fourth were of Sariki origin. Additionally, two-thirds (65%) of the children were reported to be first-borns of their parents; however, the prevalence of underweight was found to be more in the 3-plus birth order children. Thirty-seven per cent of the babies were born with average birth weight and 11% were born with low birth weight. The percentage of underweight was found to be more (45%) in low birthweight babies as compared with large and average (26% and 32%, respectively) birthweight babies. Out of the children who suffered from diarrhoea, 38% were reported to be moderately underweight and 15% were found to be severely underweight. More than half (56%) of the mothers breast fed their babies, out of which a 34% were moderately underweight while 12% were severely underweight. Over half (58%) of the mothers were between the age bracket of 25 and 35 years, out of which only 7% of the mothers had children when they were still less than 18 years old. A high prevalence of moderate 36% and 12% severe underweight was found in these children. Half of the mothers had no schooling, while 30% of the fathers had some schooling. Very few mothers (7%) had a history of smoking. One-fourth of the mothers had a history of antennal visits of up to four times during their pregnancy, while one-fifth of the mothers were approached for postnatal care. Less than one-third of the mothers had delivered their babies at hospitals. Half of the mothers were found to be living in poor wealth status household. One-third of the respondents had more than eight members in their households. More than two-thirds of the children were found to be living in poor sanitary conditions. Majority of the children, however, had access to water, which was not treated and drinkable. Very few (15%) families had access to daily newspapers and (5%) had access to radios in their homes, while nearly two-thirds of the respondents had access to televisions. Nearly one-fifth of the children were visited by female health workers at their homes. Out of the total 69.6% children who belonged to rural areas in Punjab, 36% were moderately underweight while 13% are severely underweight, whereas among the urban respondents from Punjab province, 27% were found to be moderately underweight and 7% were found to be severely underweight.

The results of multilevel multivariate models are presented in tables 2 and 3 as OR with a 95% CI. Model

Table 1 Prevalence of underweight (moderate and severe) in relation to demographic, socioeconomic, environmental and spatial characteristics in Punjab (MICS 2014)

	N (%) Total	N (%) (Underweight <−2 SD)	χ2 P value	N (%) (Underweight <−3 SD)	χ^2 P value
Variables	**24 042**	**8010 (33.32)**	**–**	**2704 (11.25)**	**–**
Sex					
Male	12 214	4005 (33)	0.208	1325 (11)	0.075
Female	11 828	3988 (34)		1377 (12)	
Age					
0–5	2083	635 (30)	<0.001	260 (13)	<0.001
6–11	2641	826 (31)		299 (11)	
12–23	4617	1604 (35)		589 (13)	
24–35	4647	1621 (35)		559 (12)	
36–47	5163	1787 (35)		581(11)	
48–59	4891	1520 (31)		414 (8)	
Ethnicity					
Urdu	1199	317 (26)	<0.001	81 (7)	<0.001
Punjabi	15 475	4797 (31)		1532 (10)	
Saraiki	5837	2325 (40)		890 (15)	
Others	1531	553 (36)		198 (13)	
Birth order					
First	15 682	4925 (31)	<0.001	1522 (10)	<0.001
Second	7041	2551 (36)		939 (13)	
Third (and up)	1319	516 (39)		241(18)	
Size at birth					
Large	1052	275 (26)	<0.001	70 (7)	<0.001
Average	8881	2798 (32)		917 (10)	
Small	2625	1178 (45)		470 (18)	
Diarrhoea					
Yes	4201	1593 (38)	<0.001	632 (15)	<0.001
No	19 841	6400 (32)		2069 (10)	
Breast feeding					
Yes	13 361	4497 (34)	0.021	1607 (12)	<0.001
No	670	205 (31)		101 (15)	
Gender of household head					
Male	23 401	7789 (33)	0.359	2638 (11)	0.835
Female	640	204 (32)		63 (10)	
Smoking mother					
No	22 472	7342 (33)	<0.001	2475 (11)	<0.001
Yes	1569	651 (41)		226 (14)	
Mother's age					
<18	1712	611 (36)	0.027	214 (12)	0.588
18–24	5197	1687 (32)		558 (11)	
25–35	13 876	4543 (33)		1528 (11)	
36+	3257	1152 (35)		402 (12)	
Mother's education					
Illiterate	11 853	4872 (41)	<0.001	1867 (16)	<0.001
Primary	4306	1421 (33)		428 (10)	
Middle	2370	637 (27)		166 (7)	
Secondary	2951	689 (23)		162 (5)	
Higher	2563	373 (15)		79 (3)	

Continued

Table 1 Continued

Variables	N (%) Total 24 042	N (%) (Underweight <−2 SD) 8010 (33.32)	χ2 P value –	N (%) (Underweight <−3 SD) 2704 (11.25)	χ^2 P value –
Father's education					
Illiterate	7094	3087 (44)	<0.001	1234 (17)	<0.001
Primary	4338	1619 (37)		549 (13)	
Middle	3948	1241(31)		375 (9)	
Secondary	5269	1406 (27)		384 (7)	
Higher	3393	638 (19)		159 (5)	
Antenatal care					
1–4 visits	6198	2197 (35)	<0.001	683 (11)	<0.001
5+ visits	3902	964 (25)		296 (8)	
Child delivery					
Home	5473	2251 (41)	<0.001	857 (16)	<0.001
Hospitals	7140	2025 (28)		608 (9)	
Wealth index					
Poor	10 839	4582 (42)	<0.001	1779 (16)	<0.001
Middle	4687	1487 (32)		446 (10)	
Rich	8515	1924 (23)		476 (6)	
Household size					
Size 3–4	2868	936 (33)	<0.001	303 (11)	0.015
Size 5–6	7109	2366 (33)		770 (11)	
Size 7–8	6003	2141(36)		760 (13)	
Size>8	8060	2549 (32)		868 (11)	
Sanitation					
Unimproved	6969	3021 (43)	<0.001	1188 (17)	<0.001
Improved	17 073	4972 (29)		1513 (9)	
Water facilities					
Unimproved	1411	380 (27)	<0.001	100 (7)	<0.001
Improved	22 631	7613 (34)		2602 (11)	
Water treatment					
Treated	1454	311 (21)	<0.001	83 (6)	<0.001
Untreated	22 587	7682 (34)		2619 (12)	
Yes	14 918	4306 (29)		1256 (8)	
Media exposure total (t otal= newspaper+ radio+ TV)					
No	8414	3473 (41)	<0.001	1372 (16)	<0.001
Yes	15 627	4519 (29)		1329 (9)	
Female health worker visit (PNC)					
No	7756	2596 (33)	0.965	880 (11)	0.695
Yes	4754	1653 (35)		576 (12)	
Division level situation					
Rawalpindi	1819	387 (21)	<0.001	102 (6)	<0.001
Bahawalpur	2847	1158 (41)		451 (16)	
D.G. Khan	2721	1165 (43)		455 (17)	
Faisalabad	3024	1031 (34)		329 (11)	
Gujranwala	3087	780 (25)		229 (7)	
Lahore	4152	1235 (30)		382 (9)	
Multan	2769	987 (36)		335 (12)	
Sahiwal	1814	636 (35)		217 (12)	
Sargodha	1807	611 (34)		201 (11)	

Continued

Table 1 Continued

Variables	N (%) Total 24042	N (%) (Underweight <−2 SD) 8010 (33.32)	χ2 P value –	N (%) (Underweight <−3 SD) 2704 (11.25)	χ^2 P value –
Regional level					
Urban	7447	2002 (27)	<0.001	554 (7)	<0.001
Rural	16595	5991 (36)		2147 (13)	

1 is an unconditional three-level hierarchical model that estimates the variation in underweight (moderate and severe) children without including any covariate and is used as a base model for comparison to check the explanatory power of the factors associated with underweight. Furthermore, model *2* includes child and parental characters, and model 3 includes household characteristics along with child, parental and regional characters (eg, administrative divisions). For example, compared with reference category of 0–5 months, the odds of being underweight is almost 50% higher for children in the age bracket of 12–23 months (OR 1.46, 95% CI 1.1 to 1.9), whereas for children between the ages of 36 and 47 months, the odds of being underweight is more than double (OR 2.54, 95% CI 1.4 to 4.5) than that of the reference category of 0 to 5 months. Although the odds of being underweight for boys compared with girls is less (OR 0.92, 95% CI 0.8 to 1.0), this difference is only significant at a 5% level of significance. Children with birth order 2 have higher odds of being underweight (OR 1.37, 95% CI 1.2 to 1.5), whereas children with birth order of 3 or more are two times more likely to be stunted (OR 1.96, 95% CI 1.5 to 2.5). Children with diarrhoea are significantly more likely to be underweight compared with those who have not had a single episode of diarrhoea (OR 1.31, 95% CI 1.1 to 1.5). Children whose size at birth is perceived to be smaller than average are more than 2.7 times as likely to be moderately underweight than those who have an average or larger than average size at the time of birth (See table 2).

Compared with mothers with no education, children of highly educated mothers are significantly less likely to be moderately underweight (OR 0.31, 95% CI 0.2 to 0.4), whereas children of mothers who have completed at least primary (OR 0.81, 95% CI 0.7 to 0.9) or middle school (OR 0.62, 95% CI 0.5 to 0.7) are significantly less likely than children of mothers with no education to be underweight. Children of fathers who have completed higher education are less likely to be underweight (OR 0.48, 95% CI 0.4 to0.6). Children living in urban areas are less likely to be moderately underweight (OR 0.81, 95% CI 0.7 to 0.9). Similarly, children who have access to improved sanitation facilities and households with higher income are significantly less likely to be moderately underweight. However, in this analysis, no significance was found between the delivery place of the child and breastfeeding practices. The results of severe underweight (less than −3 SD) are presented in table 3. The findings are in compliance with those of the moderately underweight with a similar magnitude and significance of coefficients. However, few exceptions do exist, for example, children who have not been breast fed are significantly more likely to be underweight. Similarly, children who were delivered at a hospital and those who have had media exposure are significantly less likely to be severely underweight. Household size, prenatal and postnatal care, smoking behaviour of mothers and drinking water facility were found to have no significant association with children being underweight in Punjab, Pakistan.

The results of VPC and ICC for both moderately and severely underweight children are shown in table 4. The unconditional models only decompose the total outcome variance into level-specific variance components. In conditional models 2–3 (with explanatory variables), the VPC and ICC are based on the residual rather than observed outcomes. The unconditional model (model 1) for moderate underweight shows the variance at the district level and explains 3% (=0.16/5.75) proportional change in variance (VPC) of the total variance. The community-level variance shows 4% (=0.25/5.75) of the total variation, while the household level variation implies that the risk of underweight significantly varies across households by 36% (=2.06/5.75). Similarly, the results of the ICC statistics of moderate underweight (unconditional model 1) show that the district, community and household level ICC is 0.03, 0.07 and 0.43, respectively. This implies that households living in the same community have higher chance of correlation of underweight than the households of adjacent communities. One can similarly explain other numbers of table 4 (eg, for severely underweight children).

DISCUSSION

This study used subnational-level multiple indicator cluster survey data (MICS 2014) from Punjab, Pakistan and analysed the factors associated with underweight children under the age of 5 using multilevel logistic regression models. The prevalence of underweight children was estimated to be 33% in Punjab—this has remained unchanged since 2008. MICS data analyses reveal that the prevalence of underweight children in Punjab, Pakistan is higher than expected, especially when the high level of development and government spending in the province

Table 2 Multilevel multivariable logistic regression results, Punjab (MICS 2014)

Moderate underweight (>−2 SD)

Variables	Model 1†	Model 2‡ OR (95% CI)	Model 3§ OR (95% CI)
Child age group (reference category 0–5 months)			
6–11		1.15 (0.9 to 1.5)	1.14 (0.9 to 1.5)
12–23		1.46** (1.1 to 1.9)	1.48** (1.1 to 1.9)
24–35		1.70** (1.2 to 2.5)	1.69** (1.2 to 2.5)
36–47		2.54** (1.4 to 4.5)	2.59** (1.5 to 4.6)
48–59		2.11** (1.2 to 3.7)	2.16** (1.2 to 3.8)
Child gender (reference category Girls)			
Boys		0.92** (0.8 to 1.0)	0.92** (0.8 to 1.0)
Child birth order (reference category First born)			
2		1.37*** (1.2 to 1.5)	1.37*** (1.2 to 1.5)
3+		1.96*** (1.5 to 2.5)	1.94*** (1.5 to 2.5)
Child size at birth (reference category Large size)			
Average		1.36*** (1.1 to 1.6)	1.36*** (1.1 to 1.6)
Small		2.77*** (2.2 to 3.5)	2.70*** (2.1 to 3.5)
Diarrhoea (reference category No)			
Yes		1.31*** (1.1 to 1.5)	1.29*** (1.1 to 1.5)
Breast feeding (reference category Yes)			
No		0.92 (0.7 to 1.2)	0.93 (0.7 to 1.2)
Household sex (reference category Female)			
Male		0.83 (0.6 to 1.1)	0.81 (0.6 to 1.0)
Mother's education (reference category No education)			
Primary		0.81*** (0.7 to 0.9)	0.90** (0.8 to 1.0)
Middle		0.62*** (0.5 to 0.7)	0.73** (0.6 to 0.9)
Secondary		0.55*** (0.5 to 0.7)	0.68*** (0.6 to 0.8)
Higher		0.31*** (0.2 to 0.4)	0.39*** (0.3 to 0.5)
Mother's age (reference category Age of women <18 years of age)			
18–24		0.92 (0.8 to 1.1)	0.92 (0.8 to 1.1)
25–35		0.92 (0.7 to 1.1)	0.90 (0.7 to 1.1)
36–49		0.94 (0.8 to 1.1)	0.91 (0.7 to 1.1)
Prenatal care (reference category 1–4 visits)			
More than four visits		0.87 (0.8 to 1.0)	0.92 (0.8 to 1.1)
Postnatal care to female health worker visit (reference category Yes)			
No		0.93 (0.8 to 1.0)	0.90 (0.8 to 1.0)
Delivery place (reference category Home)			
Hospital		0.85** (0.7 to 1.0)	0.89 (0.8 to 1.0)
Mother smokes (reference category No)			
Yes		1.17 (1.0 to 1.4)	1.11 (0.9 to 1.3)
Father's education (reference category No education)			
Primary		0.89 (0.8 to 1.0)	0.94 (0.8 to 1.1)
Middle		0.72*** (0.6 to 0.8)	0.79** (0.7 to 0.9)
Secondary		0.58*** (0.5 to 0.7)	0.66*** (0.6 to 0.7)
Higher		0.48*** (0.4 to 0.6)	0.55*** (0.4 to 0.7)
Wealth index (reference category Poor)			
Middle			0.81** (0.7 to 0.9)
Rich			0.63*** (0.5 to 0.7)

Continued

Table 2 Continued

Moderate underweight (>−2 SD)			
Variables	Model 1†	Model 2‡ OR (95% CI)	Model 3§ OR (95% CI)
HH size (reference category HH size 3–4 members)			
5–6 members			1.01 (0.9 to 1.2)
7–8 members			1.07 (0.9 to 1.3)
>8 members			0.97 (0.8 to 1.2)
Ethnicity (reference category Urdu)			
Punjabi			0.80 (0.6 to 1.0)
Saraiki			0.70** (0.5 to 0.9)
Others			0.88 (0.7 to 1.2)
Sanitation facility (reference category Unimproved)			
Improved			0.80*** (0.7 to 0.9)
Drinking water facility (reference category Unimproved)			
Improved			1.12 (0.9 to 1.3)
Water treatment (reference category Untreated)			
Treated			0.84 (0.7 to 1.0)
Media exposure (reference category No)			
Yes			0.92 (0.8 to 1.0)
Region (reference category Rural)			
Urban		0.81** (0.7 to 0.9)	1.07 (1.0 to 1.2)
Division (reference category Rawalpindi division)			
Bahawalpur			1.72** (1.2 to 2.6)
D.G. Khan			1.78** (1.2 to 2.6)
Faisalabad			1.77*** (1.4 to 2.3)
Gujranwala			1.09 (0.8 to 1.4)
Lahore			1.55*** (1.2 to 1.9)
Multan			1.51** (1.2 to 2.0)
Sahiwal			1.43** (1.1 to 1.8)
Sargodha			1.42** (1.1 to 1.8)
Constant	−1.022***	0.06*** (0.0 to 0.1)	0.36*** (0.2 to 0.6)
Different levels variance			
Level 1 (Household)	2.06***	2.027***	2.025***
Level 2 (Community)	0.25***	0.15***	0.139**
Level 3 (District)	0.16***	0.05**	0.009
Log pseudolikelihood	−14367.528	−13872.00	−13814.16
Observations	24 042	24 042	24 042

*P< 0.05; **p<0.01; ***p<0.001.
†Base model (unconditional three level hierarchical model).
‡Hierarchical model with child and parental characteristics.
§Hierarchical model with child, parental, household and division.

is taken into account. These figures are higher even than those of neighbouring countries including Afghanistan and Nepal,[13 25] and are only slightly less than those of India and Bangladesh.[7 26 27] Furthermore, this study, using multilevel logistic regression model, estimated the factors associated with the prevalence of moderate and severe underweight. Maternal and household risk factors included low education levels, smoking history, antenatal care visits, not having the delivery assisted by a health professional, access to safe drinking water, sanitation, bigger household size, living area and poor wealth index. Regional studies show that income, mother's educational level and access to safe drinking water are the main factors which lead to children being underweight.[28–30]

Children suffering from diarrhoea were significantly more likely to be moderately and severely underweight compared with the children who had not suffered from an episode of diarrhoea in the 2 weeks prior to the survey.

Table 3 Multivariable regression results of multilevel models Punjab (MICS 2014)

Severe underweight (> –3SD)			
Variables	**Model 1†**	**Model 2‡OR (95% CI)**	**Model 3§ OR (95% CI)**
Child age group (reference category 0–5 months)			
6–11		0.95 (0.7 to 1.2)	0.94 (0.7 to 1.2)
12–23		1.15 (0.9 to 1.5)	1.17 (0.9 to 1.5)
24–35		1.20 (0.9 to 1.6)	1.19 (0.9 to 1.5)
36–47		0.65 (0.3 to 1.7)	0.65 (0.3 to 1.6)
48–59		0.45 (0.2 to 1.2)	0.45 (0.2 to 1.1)
Child gender (reference category Girls)			
Boys		0.88** (0.8 to 1.0)	0.88* (0.8 to 1.0)
Child birth order (reference category First born)			
2		1.42*** (1.3 to 1.6)	1.40*** (1.2 to 1.6)
3+		2.42*** (1.8 to 3.3)	2.35*** (1.8 to 3.0)
Child size at birth (reference category Large size)			
Average		1.58** (1.2 to 2.2)	1.58* (1.1 to 2.2)
Small		3.24*** (2.4 to 4.4)	3.13*** (2.2 to 4.5)
Diarrhoea (reference category No)			
Yes		1.60*** (1.4 to 1.9)	1.58*** (1.4 to 1.8)
Breast feeding (reference category Yes)			
No		1.65** (1.1 to 2.4)	1.69** (1.2 to 2.3)
Household sex (reference category female)			
Male		0.80 (0.5 to 1.2)	0.77 (0.5 to 1.2)
Mother's education (reference category No education)			
Primary		0.70*** (0.6 to 0.8)	0.82* (0.7 to 1.0)
Middle		0.50*** (0.4 to 0.6)	0.64*** (0.5 to 0.8)
Secondary		0.44*** (0.3 to 0.6)	0.60*** (0.5 to 0.8)
Higher		0.27*** (0.2 to 0.4)	0.37*** (0.3 to 0.5)
Mother's age (reference category age of women <18 years of age)			
18–24		0.97 (0.7 to 1.4)	0.98 (0.8 to 1.3)
25–35		0.98 (0.7 to 1.4)	0.97 (0.8 to 1.2)
36–49		0.98 (0.7 to 1.3)	0.95 (0.7 to 1.2)
Prenatal care (reference category 1–4 visits)			
More than four visits		1.11 (1.0 to 1.3)	1.21 (1.0 to 1.5)
Postnatal care to female health worker visit (reference category Yes)			
No		0.89 (1.0 to 1.3)	0.94 (1.0 to 1.4)
Delivery place (reference category Home)			
Hospital		0.79** (0.7 to 0.9)	0.84* (0.7 to 1.0)
Mother smokes (reference category No)			
Yes		0.95 (0.8 to 1.2)	0.89 (0.7 to 1.1)
Father's education (reference category No education)			
Primary		0.80*** (0.7 to 0.9)	0.86 (0.7 to 1.0)
Middle		0.63*** (0.5 to 0.8)	0.71*** (0.6 to 0.8)
Secondary		0.50*** (0.4 to 0.6)	0.58*** (0.5 to 0.7)
Higher		0.44*** (0.3 to 0.6)	0.53*** (0.4 to 0.7)
Wealth index (reference category Poor)			
Middle			0.78** (0.7 to 0.9)

Continued

Table 3 Continued

Severe underweight (> −3SD)			
Variables	**Model 1†**	**Model 2‡OR (95% CI)**	**Model 3§ OR (95% CI)**
Rich			0.59*** (0.5 to 0.7)
HH size (reference category HH size 3–4 members)			
5–6 members			1.05 (0.9 to 1.3)
7–8 members			1.17 (1.0 to 1.4)
>8 members			1.07 (0.9 to 1.3)
Ethnicity (Reference category Urdu)			
Punjabi			0.88 (0.6 to 1.2)
Saraikai			0.82 (0.6 to 1.2)
Others			0.90 (0.6 to 1.3)
Sanitation facility (reference category Unimproved)			
Improved			0.83** (0.7 to 0.9)
Drinking water facility (reference category Unimproved)			
Improved			1.20 (0.9 to 1.6)
Water treatment (reference category Untreated)			
Treated			0.80 (0.6 to 1.1)
Media exposure (reference category No)			
Yes			0.82** (0.7 to 0.9)
Region (reference category Rural)			
Urban		0.91* (0.8 to 1.0)	1.04 (0.9 to 1.2)
Division (reference category Rawalpindi division)			
Bahawalpur			1.72** (1.2 to 2.4)
D.G. Khan			1.74** (1.2 to 2.4)
Faisalabad			1.71*** (1.2 to 2.4)
Gujranwala			1.17 (0.9 to 1.6)
Lahore			1.54** (1.1 to 2.1)
Multan			1.47* (1.1 to 2.1)
Sahiwal			1.43* (1.0 to 2.0)
Sargodha			1.45* (1.0 to 2.1)
Constant	−2.85***	0.36*** (0.2 to 0.5)	0.05*** (0.0 to 0.1)
Variation at different levels			
Level 1 (Household)	1.949***	1.961***	1.949***
Level 2 (Community)	0.278***	0.188***	0.165**
Level 3 (District)	0.161**	0.022*	0.009
Log pseudolikelihood	−8067.020	−13872.00	−7610.8
Observations	24 042	24 042	24 042

*P<0.05; **p<0.01; ***;<0.001.
†Base model (unconditional three level hierarchical model).
‡Hierarchical model with child and parental characteristics.
§Hierarchical model with child, parental, household and division.

Diarrhoea results in dehydration and a loss of appetite; these factors lead to adverse child health outcomes such as underweight. This finding is supported by a study from Bangladesh, which shows that diarrhoea during childhood has a significant effect on undernutrition.[7] Another study revealed that wasting results in chronic illness and infections like diarrhoea.[31] Another study from Nepal suggests that safe drinking water prevents diarrhoea, which ultimately leads to a reduction in childhood underweight.[13] Underweight in children increases the chances of developing other infections due to their low immunity against infectious agents.[32] On the other hand, high

Table 4 Results from random intercept model: measure of variation VPC and ICC

Models	Model 1		Model 2		Model 3	
SD	−2 SD	−3 SD	−2 SD	−3 SD	−2 SD	−3 SD
Variance partition coefficient (VPC)						
VPC_{distt}	0.03	0.03	0.009	0.004	0.002	0.002
VPC_{comm}	0.04	0.05	0.03	0.03	0.03	0.03
VPC_{hh}	0.36	0.34	0.37	0.36	0.37	0.36
Intraclass correlation (ICC)						
ICC_{distt}	0.03	0.03	0.009	0.004	0.002	0.002
ICC_{comm}	0.07	0.08	0.039	0.034	0.032	0.032
ICC_{hh}	0.43	0.42	0.409	0.394	0.402	0.392

metabolic demand for infection can result in weight loss among babies due to reduced food absorption and loss of appetite.[10] Community interventions, including provision of nutrients, have a positive impact on the child's health, which ultimately helps prevent infections and improve their immunity.[33–36] The size of the child at time of birth was significantly associated with their nutritional status. Children who were of a size smaller than average at birth were more prone to underweight as compared with children who were of an average or larger than average size at birth. These findings are consistent with previous studies.[30 37 38]

Our study shows that mother's education was correlated with dietary status among children under 5 years of age and showed a lack of relationship between prenatal/postnatal care and underweight. Mother's education has a positive affect on the child's health and leads to positive health seeking behaviour with mothers paying more attention to antenatal and postnatal checkups. Educated mothers could manage households in a better way and provide a more nutritious diet to their children. These findings are similar to previous researches conducted in Bangladesh, which confirmed that underweight was associated with lower parental education.[7] The study also shows a strong association between institutional delivery and mother's education, which in turn affects child health.[39] Female education status is very low in Pakistan which might be a contributing factor towards the high burden of underweight in children.[28] Research suggests that 10 years of education or more among mothers can lead to the reversal of almost half of the malnutrition burden among children in high prevalent areas of the developing world.[8] Educated mothers are well informed about the ways to provide care to their children and show positive practices with regard to health and hygiene, breast feeding and empowered decision making in health.[12 35] Smoking behaviours in mothers, in our study, were not significantly associated with underweight, this may be due to the small number of smoking mothers in the sample.

Place of delivery highly impacts the weight of children according to this study. Children born at home are significantly more likely to be underweight as compared with those delivered at a health facility. These results are in line with studies from Bangladesh, India and Nepal.[26 40 41] It can be inferred that giving birth at home is mostly preferred by uneducated mothers[42]; women with low levels of education do not have awareness and are not empowered to make decisions about the best care they can provide for their child. In most cases, these mothers are also unaware about the benefits of institutional delivery and the harmful impacts of not getting proper postnatal care offered by hospitals which can affect the nutrition that their child gets and they miss out on early healthcare advantages that help in better child health outcomes.[38] Underweight among children is reported high among families that have more than three children. Repeated pregnancies are a significant cause of poor health among mothers, as also shown by previous studies. It had also previously been found that multiple childbirths adversely impact mother and child's health.[38 43]

Parents of children in this survey who had access to media (television, radio and newspaper) reported low underweight in their babies. These results indicate that these parents were aware of the latest trends and practices to ensure provision of proper nutrition to their children. Our results are consistent with similar findings in studies conducted in Nigeria and Bangladesh that show the helpful link between the use of media and underweight.[38 44] This study shows that families of children that live in rural areas were more underweight as compared with those living in urban areas. This could be due to the poor health infrastructure and lack of availability of healthcare professionals and lack of equipment available in rural health facilities.[12] Unsafe drinking water, poor sanitation, improper housing and low literacy in the area would positively affect nutrition of children and health of people. This imbalance in the resources would make their children more vulnerable to infections and illnesses that ultimately cause underweight. These findings are consistent with a study conducted in Congo, which shows that there were more underweight babies in rural areas as compared with urban centres.[44] In this study, breast feeding, household size and prenatal and postnatal care have no significant effect on children's health status.

However, our study does have some limitations. First, the analyses are based on cross-section data and hence we cannot conclude any causal relationship among factors associated with moderate and severe underweight. Second, even though this study has been conducted across the largest province of Pakistan, the results of the study cannot be generalised at the country level. Nevertheless, the results can be helpful in understanding the dynamics of the factors associated with underweight in the province and can provide a substantial guideline and starting point for better policy formulation and interventions.

CONCLUSION

Based on our findings, a rigorous community-based intervention should be developed and executed throughout the province to improve the grave situation of underweight prevalence. Mother's education should be uplifted by providing formal education and awareness about nutrition. Health system access for underprivileged and poor households could be improved by providing proper health facilities in rural areas. Proper family planning and gap between subsequent child births should be maintained to achieve better health for both the mother and the child. Hence, it is recommended that the policy makers should focus on these interventions to improve the nutritional status among children under the age of 5 in Pakistan.

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Contributors FA and RK performed the literature search and conceptualised this study. Data analysis was done by TM with input from FA as well as interpretation of multilevel results. The manuscript was drafted by RK and FA and reviewed by FA, RS and TM. All the authors were involved in revision and editing of the draft. All authors critically reviewed the final manuscript and approve the draft for final submission.

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