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Is high availability of fruit and vegetable beneficial for children with anemia? A cross-sectional study in two peri-urban communities from Pakistan

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ABSTRACT

Introduction: In developing countries about half of young children are affected by anemia with about 54% of children aged under five suffering from moderate to severe anemia in Pakistan. The aim of this study was to investigate the community, household and individual level factors associated with anemia among children aged 1-5 years and to estimate the prevalence of anemia.

Methods: A community-based cross-sectional study was conducted among children in two peri urban communities of Karachi Pakistan. Systematic sampling method was used. A structured questionnaire was used to collect information on independent variables. The dependent variable was anemia which was measured by Hemacue machine. Binary multilevel logistic regression was used to analyze the data.

Results: The prevalence of mild, moderate and severe anemia in 1-5 year old children was 17.6%, 57.7% and 14.8%, respectively. The community level factors found to be negatively associated with anemia were living in neighborhoods with high availability of fruit [Adjusted Odds Ratio (AOR) = 0.3, 95% Confidence Interval (CI): 0.1-0.6], and residing in neighborhoods with high number of meat and dairy product and vegetable shops (AOR=0.4, 95% CI: 0.2-0.9). The household and individual level factors found to be positively associated with anemia were mothers with 4 or more children (AOR = 1.9, 95% CI: 1.2-3.1), younger age (AOR = 2.0, 95% CI:1.3-3.1) and child not being vaccinated (AOR = 1.9, 95% CI: 1.0-3.6).

Conclusion: We found a high prevalence of anemia in children living in two peri urban communities. The public health measures call for improvements in nutrition facilities in the neighborhoods, vaccination of child and reduction in the number of family members.

Introduction

Worldwide about 43% and in developing countries about half of young children (6-59 months) are suffering from anemia (1, 2) with Asia (55%) and Africa (60%) as the most affected areas (3, 4). Iron Deficiency Anemia (IDA) is the most common type of anemia among children (5). Also in Pakistan, though the prevalence of moderate to severe anemia in children under five has decreased from 62% in 2011 (6) to 53.7% in 2018 (7), the statistics are still high.

According to the World Health Organization (WHO), anemia is defined as a medical condition in which there are decreased concentrations of hemoglobin (Hb) in the blood; more specifically, children ranging from ages six months up to five years having Hb concentration $< 11g/dL$ are considered anemic (3). Childhood anemia has been linked with poor physical development, mental impairment and reduced motor development which greatly affects a child's daily activities (8). Anemia has different types and severities; however, IDA has been associated with an increased risk of child morbidity and mortality (8). The initial few years of life are crucial in terms of a child's biological and psychosocial development. During this period, infants and young children with IDA are more prone to developmental problems. These may include irregularities in the cognitive, social, emotional and adaptive functions (9, 10).

Although a considerable amount of work has been done in Pakistan to assess risk factors of anemia but most of the information has been collected on individual level risk factors. Studies that focus solely on individual risk factors are not able to determine the social factors of the disease and the role that societies play in an individual's health (11). Literature suggests that neighborhoods that provide access to high quality foods and fruits by increasing the availability of food stores have the potential to increase the household consumption of those foods and fruits thereby improving the diet and weight outcomes of individuals living in the neighborhoods (12, 13). This proposes

that factors that operate at a higher level such as the community and neighborhood may have remarkable influence on an individual's behavior and health, and the high prevalence of anemia may be related to multiple community, household and individual level factors.

Considering that there is limited data available on multilevel factors specifically the community level factors of childhood anemia, this study was conducted to assess the effects of community, household and individual level factors simultaneously on childhood anemia in two peri-urban communities of Karachi. Secondly, this study aimed to estimate the prevalence of anemia in children living in the mentioned communities. The findings will further broaden the understanding about the impact of numerous multi-level factors related to childhood anemia.

Methods

Study design and study setting

This was a cross-sectional analytical study conducted from March to June 2014 in two peri-urban communities (Cattle Colony & Rehri Goth) (Figure 1) of Karachi, Pakistan. Karachi is a metropolitan city of Pakistan located in the south of the country which consists of 18 towns (14). Rehri Goth is located in Bin Qasim town of Karachi which contains 16 sectors (paras) with an overall population of 70,000. Fourteen percent (14%) of the population is under five children. The major occupation of people residing in this area is fishing (15). Cattle Colony is other peri-urban locality in Bin Qasim town which is the hub of cattle and meat trade in Karachi (16). Most of the population includes low- and middle-income households (14).

Figure 1: Map of study sites

Study population

The statistical population of this study included children aged 1-5 years living in two peri-urban communities (Cattle Colony & Rehri Goth) of Karachi, Pakistan.

Eligibility criteria

Children aged 1-5 years, living in the mentioned communities for the past 6 months were included in the study. Participants with a known history or current case of aplastic anemia, acute lymphoblastic leukemia, thalassemia, malaria and tuberculosis were excluded after taking medical history and checking medical records.

Sample size and sampling method

Based on the national prevalence of stunting and wasting, and assuming a prevalence ratio of at least 1.75, alpha level of 5% (two sided) and a power of at least 80%, we required a sample size of atleast 479 participants. However, we achieved 494 participants who were analyzed. Systematic sampling method was used. The sampling interval (k) was calculated by dividing the total population (N) by the sample size (n), which came out to be 30. Between 1 to 30 children, a child was randomly chosen and then every 30th child was selected following the first random number (9 in our case). Based on the distribution of under five children population, the sample size was proportionally distributed between the two communities taking 36% participants from Rehri Goth and 64% from Cattle Colony. In case of two or more eligible children in a household, only one of them was chosen randomly.

Data collection

Four data collectors comprising two senior Community Health Workers (CHWs) and two graduate Research Assistants (RAs) were thoroughly trained for proper data collection, editing and management and measurement of Anemia. Information on community, individual and household level variables was collected using structured pretested questionnaires. The questionnaires were translated from English into simple Urdu language which both the interviewer and the participants could understand well.

The community level information questionnaire contained details on socio-demographic, infrastructure and nutrition related variables. The infrastructure related variables included garbage disposal mechanisms, condition of streets, drainage system, mode of public transport, presence of educational institutions and health facilities in the community. The nutrition related variables included the presence of vegetable, meat and milk shops and the availability of foods (beef, chicken, mutton & egg) and fruits (dates, mango, peach, apricot etc.) in the markets. There were 34 neighborhoods/residential blocks (16

in Rehri Goth and 18 in Cattle Colony) which are called *Paras* in local language, and each neighborhood was taken as a community.

The household level variables included socio-demographic details, household monthly income, family system, number of alive children, household size, having a smoker in the household, household food security status, type of cooking fuel used, maternal age, educational level of mother and father, and knowledge of mother about rich foods.

The individual level factors were child's age, sex, birth order, vaccination status, exclusive breastfeeding status, deworming history, history of respiratory infection in the last two weeks, daily food intake and anthropometry. To assess daily food intake food frequency questionnaire (FFQ) was used which contained details on the frequency and amount of each food consumed. Anemia was measured through HemoCueHb 201^{+}(HemoCueHb, Angelholm, Sweden) which is a point-of-care testing device. For testing hemoglobin (Hb), a drop of capillary blood was obtained by puncturing fingertip with a lancet needle.

Statistical analysis

Descriptive continuous data such as age, household income and nutrient intake was reported as mean with standard deviation (SD) or median with interquartile ranges (IQR). For all categorical data, frequencies and percentages were reported. Chi square test was used to test the association between categorical variables. For meaningful analysis and easier interpretation of findings, the raw community level data was reduced to one or more composite variables using factor analysis and scores were generated for each factor to use it for further analysis. A single component was generated for the socio-demographic variables whereas for the nutrition related variables, four components were retained based on eigenvalue >1. The anthropometric data was analyzed using the WHO Anthro Plus (version 1.0.4) software to drive the nutritional indicators (i.e., stunting, wasting and underweight). A Z-score of <-2 for Height-for-Age, BMI-for-Age and Weight-for-Age was labeled as stunting, wasting and underweight, respectively. Due to insufficient number of non-anemic children the number of mildly anemic children was merged with the number of non-anemic to create the binary categories of outcome (Normal & Moderate-Severe anemic) for valid analysis.

Given the hierarchical nature of data we used multilevel logistic regression. We constructed three successive models. In the first model, we had individual and household level factors. The second model included only community level (neighborhood) factors while the third model contained all the community, household and individual level factors. The results presented in this paper are based on the final model (model 3). A p-value of ≤0.25 at univariate and ≤0.05 at multivariable level was considered significant. Multicolinearity among independent variables was assessed and all biologically plausible confounders were adjusted in multivariable model. In all analysis, p-value, crude and adjusted odds ratio (OR) and 95% confidence interval (CI) were reported. All statistical analyses were undertaken in Stata version 12.

Ethical approval

Written informed consent was obtained from parents of the participants before the interview. Ethical approval (#2758-CHS-ERC-13) was taken from the Ethical Review Committee (ERC) at the Aga Khan University Karachi Pakistan.

Results

Neighborhood characteristics

In majority (88.2%) of the neighborhoods, garbage was openly dumped on the side of streets. Only 32.4% had paved and well maintained streets. Most of the neighborhoods (64.7%) had a closed drain system for waste water. About 67.6% neighborhoods used public bus or Rickshaw for routine transportation. About 35.3% and 67.6% of neighborhoods did not have any primary and secondary school, respectively. Most of the neighborhoods (61.8%) had a functioning health facility. Grocery shops existed in almost all (88.2%) neighborhoods with 55.9% having one or two vegetable shops. Nearly 21% did not have any milk shop while only 38% had one or more meat shops. Beef, mutton, chicken and egg were available in 29.4%, 11.8%, 47% and 55.9% of the neighborhoods, respectively. Dates, mango, apricot and peach were available in 35.3%, 82.4%, 61.8% and 44.1% of neighborhoods, respectively.

Individual and household level characteristics

In the total sample of 494 participants, almost half (51.2%) were aged 1-2.9 years. The mean age of children was 2.96 (±1.09) years. The proportion of male was slightly higher (52%). About 61% children were exclusively breastfed till initial six months after birth. Half of the total children (50.2%) were completely vaccinated. Only 18.2% children had received vitamin A medicine in the past six months. The proportion of stunted, wasted and underweight children was 63.9%, 17% and 49%, respectively. The median daily total dietary iron intake of children was 2.8 mg (IQR:1.7-4.1) (Table 1).

Table 1. Distribution of individual level characteristics of children aged 1-5 years in two peri-urban communities of Karachi, Pakistan (N=494)

Characteristics	Overall (n, %)	Normal (Hb≥10 g/dl) N=136 (n, %)	Moderate-Severe Anemic (Hb<10 g/dl) N=358 (n, %)	P value
Child's age(years)				
1-2.9	253 (51.2)	53 (39)	200 (55.8)	
3-5	241 (48.8)	83 (61)	158 (44.2)	0.001
Mean age(±SD)	2.96 (1.09)	3.14 (1.13)	2.89 (1.07)	
Sex				
Male	257 (52)	67 (49.3)	190 (53)	0.449
Received exclusive breastfeeding till 6 months	300 (60.7)	79 (55.8)	221 (61.7)	0.459
Vaccination status				
Completely vaccinated	248 (50.2)	80 (58.8)	168 (47)	
Partially vaccinated	154 (31.2)	40 (29.4)	114 (31.8)	
Not vaccinated	92 (18.6)	16 (11.8)	76 (21.2)	0.021
Received vitamin A in the past 6 months	90 (18.2)	26 (19)	64 (17.8)	0.831
Stunting status				
Stunted(HAZ <-2)	316 (63.9)	76 (55.8)	240 (67.0)	0.021

Table 1. Continued

Wasting status				
Wasted (BAZ<-2)	84 (17)	21 (15.4)	63 (17.6)	0.351
Underweight status				
Underweight (WAZ<-2)	242 (49)	57 (42)	185 (51.7)	0.052
Total iron (mg/day), Median (IQR)	2.8 (1.7-4.1)	2.9 (1.6-4.2)	2.7 (1.7-4.1)	0.599

Pearson Chi-square test or Mann-Whitney test (p <0.05 is considered as significant)

Majority (60%) of participants' mothers were aged 25 to 34 years. Majority (58%) of participants' mothers had 1 to 3 children. Only 28% mothers had corrected knowledge about iron rich foods. The median monthly household income was Rs.12,000 rupees. Only 37.9% households were food secure. The median household size was eight members (Table 2).

Table 2. Distribution of maternal and household level characteristics among children aged 1-5 years in two peri-urban communities of Karachi, Pakistan

Characteristics	Overall (n, %)	Normal (Hb≥10g/dl) N=136 (n, %)	Moderate-Severe Anemic (Hb<10g/dl) N=358 (n, %)	P value
Mother's age(years)				
<25	106 (21.4)	29 (21.3)	77 (21.5)	
25-34	296 (60)	84 (61.7)	212 (59.2)	
35& above	92 (18.6)	23 (17)	69 (19.3)	0.817
Number of children[a]				
1-3	287 (58.1)	87 (64)	200 (55.8)	
≥4	205 (41.5)	48 (35.3)	157 (43.9)	0.091
Mother has correct knowledge about iron-rich foods	140 (28.3)	41 (30.1)	99 (27.7)	0.583
Household monthly income(rupees)				
<10,000	110 (22.3)	27 (19.9)	83 (23.2)	
10,000-14,999	180 (36.4)	49 (36)	132 (36.9)	0.567
15,000 & above	204 (41.3)	60 (44.1)	143 (39.9)	
Median household income(IQR)	12,000 (10,000-15,000)	12,000 (10,000-16,000)	10,000 (10,000-15,000)	0.117
Household food security				
High	187 (37.9)	54 (39.7)	133 (37.2)	
Low	150 (30.4)	46 (33.8)	104 (29)	0.276
Very low	157 (31.7)	36 (26.5)	121 (33.8)	
Household size (members)				
<5	65 (13.2)	22 (16.2)	43 (12)	
5-6	127 (25.7)	33 (24.3)	94 (26.3)	
7-8	109 (22.1)	27 (19.9)	82 (23)	
9-10	62 (12.5)	13 (9.5)	49 (13.6)	0.388
>10	131 (26.5)	41 (30.1)	90 (25.1)	
Household size Median(IQR)	8 (5-11)	7 (5-11)	8 (5-11)	0.967

[a] Data missing on two participants

Pearson Chi-square test or Mann-Whitney test (P < 0.05 is considered as significant)

Multivariable analysis

Children who lived in neighborhoods with a high availability of fruits in the market had lower odds of anemia as compared to those who lived in neighborhoods with low availability of fruits (AOR=0.3, 95% CI: 0.1-0.6). Also, children who lived in neighborhoods with the presence of higher number of food and vegetable shops had decreased odds of anemia as compared to those who lived in neighborhoods which had none or lesser number of these facilities (AOR=0.4, 95% CI: 0.2-0.9). Similarly, odds of anemia were higher among children of mothers who had ≥4 children as compared to mothers with 1-3 children (AOR=1.9, 95% CI: 1.2-3.1). The odds of anemia in younger children (1-2.9 years) were higher as compared to older children (3-5 years) (AOR=2.0, 95% CI: 1.3-3.1). The odds of anemia were also higher among unvaccinated children as compared to fully vaccinated children (AOR=1.9, 95% CI: 1.0-3.6) (Table 3).

Table 3. Univariate & Multivariable analysis of community, household and individual level factors with odds ratio (OR) and 95% confidence interval (CI)

Variable	Crude OR (95%CI)	Adjusted OR (95%CI)
Community Development Index		
Tertile-1 (low)	1.0	
Tertile-2 (Medium)	1.1 (0.6-2.0)	1.3 (0.7-2.5)
Tertile-3 (High)	0.5 (0.3-0.9)	0.9 (0.5-1.6)
Availability of fruits in the market		
Tertile-1 (low)	1.0	
Tertile-2 (Medium)	1.2 (0.7-2.3)	0.8 (0.5-1.6)
Tertile-3 (High)	0.6 (0.3-1.1)	0.3 (0.1-0.6)
Presence of food & vegetable shops		
Tertile-1 (low)	1.0	
Tertile-2 (Medium)	1.2 (0.7-2.2)	0.9 (0.5-1.5)
Tertile-3 (High)	0.6 (0.3-1.2)	0.4 (0.2-0.9)
Number of children alive		
1-3	1.0	
≥4	1.6 (1.0-2.6)	1.9 (1.2-3.1)

Table 3. Continued

Child's age(years)		
1-2.9	1.9 (1.3-2.9)	2.0 (1.3-3.1)
3-5	1.0	
Vaccination status		
Completely vaccinated	1.0	
Partially vaccinated	1.3 (0.8-2.1)	1.2 (0.7-1.9)
Unvaccinated	2.1 (1.1-4.0)	1.9 (1.0-3.6)

Discussion

In this study we observed a strong association between community level factors and anemia in addition to the household and individual level factors in children living in Rehri Goth and Cattle Colony in Karachi Pakistan. After controlling for the household and individual level factors we found that children living in neighborhoods where the availability of fruits shops was higher had less prevalence of anemia as compared to those who lived in neighborhoods that had no or very little availability of fruits shops. Similarly, children residing in neighborhoods that contained a higher number of meat, dairy products and vegetable shops were likely to have a lower prevalence of anemia than those who were living in neighborhoods without these facilities. At household and individual level, children of mothers having 4 or more children, younger and unvaccinated children were more at risk of anemia.

In this study high availability of fruit, food and vegetable shops in neighborhoods was found to be protective against the risk of anemia. Though, to the best of our knowledge, no earlier studies have been conducted on the relationship between anemia prevalence and availability of vegetable and fruit shops, our study results can be explained by a number of related studies conducted in different populations on the association between easy accessibility of grocery markets and increased consumption of fruits and vegetables. For example, a study carried out on the households participating in the US Food Stamp Program found a positive association between easy access to supermarkets and enhanced household consumption of fruits (17). Similarly, availability of vegetables measured in linear shelf life in small food stores and higher number of retail food stores in neighborhoods were found to be linked to greater consumption of vegetable and fruit intake (13, 18). In addition, a community case study in Cobb County Georgia also reported that improving the accessibility of fresh fruits and vegetables by establishing fresh farm market in the community led to a higher purchase and intake of these items by customers (19). This proposes that in order to improve the consumption of iron rich foods, vegetables and fruits at household level it is vital to ensure the easy availability of these items in the markets.

In our study we did not observe any association between the community development index and risk of anemia. This is in contrast with the findings of a study conducted in Benin Africa, which showed that children residing in communities with low development level were at more risk of anemia as compared to children living in communities with high development level (20). The lack of association between the community development index and risk of anemia in our study may be due to small sample size which warrants further large studies in different settings to fully understand this relation.

Among the household level factors we observed that having more number of children is a risk factor for anemia, which is consistent with a previous study (21). Larger family size has been found to be associated with severe acute malnutrition (22, 23). This could be due to inadequate availability and poor distribution of food among large families. Having more number of children may increase the demand for food, and insufficient intake of food results in nutritional deficiencies thereby leading to anemia (24).

Among the individual level factors, younger children were more likely to have anemia as compared to older children, which is in agreement with previous studies (25, 26). The likely reason is that young and growing children have a greater need for micronutrients including iron, vitamin A and vitamin B, and failure to meet this demand may lead to anemia in these children (27). This highlights the need for focusing on the first 1000 days of child's age which is a crucial period for child development. Similarly, unvaccinated children were more prone to anemia than fully vaccinated children. This supports the findings of a previous study which found that as compared to fully vaccinated children those who were incompletely vaccinated had more risk of anemia (20). One likely explanation could be that unvaccinated children become more prone to infections, which in turn can contribute to under nutrition. Secondly, increased inflammation due to environmental enteropathy could decrease the absorption of micronutrients thus leading to anemia (28).

According to our study the prevalence of anemia in children aged 1-5 years living in Cattle Colony and Rehri Goth of Karachi, was 90% (95% CI: 87%-92%) which is higher than the prevalence (53.7%) reported in the National Nutrition Survey (NNS) 2018 for under five children at national level (7). The possible reasons could be that the Pakistan NNS 2018 used laboratory method to estimate anemia. Conversely, we used Hemocue machine which has been reported to underestimate Hb values thus resulting in slightly overestimation of anemia (29). Moreover, NNS provides an average national figure on anemia that may not truly depict the prevalence in peri-urban settlements of Sindh, which are considerably different in terms of socio-economic development, availability of health facilities and other infrastructure from rest of Sindh. Secondly, higher prevalence of anemia has been associated with low socio-economic status (30). And the data also shows that the communities where we conducted our study are quite poor with a median monthly income of 12,000 (Pakistani Rupees) and median household size of 8 members per family. We also found that the median daily total iron intake of children was 2.8mg, which is much lower than the recommended daily intake (7-10mg) for the age group of 1-8 years (31).

This study attempted to examine a broader range of associated factors, especially the community level factors in relation to childhood anemia through a multilevel analysis approach which to the best of our knowledge has not been used before to understand the association between childhood anemia and its multilevel factors. However, there are some limitations to our work as well, which include the use of Hemocue machine to measure Hb which is an indicator of anemia; therefore, we cannot differentiate between IDA and other forms of anemia from this study. Secondly, most of the data including history of RTI, diarrhea and deworming in the past 6 months, exclusive breasting feeding status, household income and food insecurity, were based on recall, which may be subject to recall bias. Finally, given the cross-sectional nature of the study, temporality cannot be established.

Conclusion

In this study we observed that having a high availability of fruit, vegetable and food shops in neighborhoods was protective against the risk of childhood anemia. To better understand the determinants of anemia it is imperative to devote serious attention toward community level factors, apart from household and individual level factors. The government can introduce subsidy programs for vegetable and fruits markets in peri-urban communities to ensure the availability and easy access of these items to reduce the burden of anemia prevalence in these areas.

Ethical disclosure

Written informed consent was obtained from parents of the participants before the interview. Ethical approval (#2758-CHS-ERC-13) was taken from the Ethical Review Committee (ERC) at the Aga Khan University Karachi Pakistan.

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Author contributions

All authors contributed to the study design, implementation, analysis and review of the manuscript.

Conflict of interest

This is an original study and has not been published elsewhere, and all authors have no conflict of interest related to the study.

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References

1. Shenton LM, Jones AD, Wilson ML. Factors associated with anemia status among children aged 6–59 months in Ghana, 2003–2014. Matern Child Health J. 2020;24:483-502. doi:10.1007/s10995-019-02865-7
2. Rahbar MH, Hozhabri S, Wang J. Prevalence of anaemia among children living in five communities in and near Karachi, Pakistan. Toxicol Environ Chem. 2007;89(2):337-46. doi:10.1080/02772240601025038
3. Balarajan Y, Ramakrishnan U, Ã–zaltin E, Shankar AH, Subramanian SV. Anaemia in low-income and middle-income countries. Lancet. 2012;378(9809):2123-35. doi:10.1016/S0140-6736(10)62304-5
4. Ritchie H, Roser M. Micronutrient deficiency. Our World in data. 2017 Aug 11.
5. Ullah I, Zahid M, Sthanadar AA, Sthanadar IA, Ali PA, Khan MI, et al. Iron Deficiency Anemia in School Age Children in District Karak Khyber Pakhtunkhwa Province, Pakistan. Open J Blood Dis. 2014;4(2):9-15. doi:10.4236/ojbd.2014.42002
6. Bhutta ZA, Soofi SB, Zaidi SS, Habib A. Pakistan national nutrition survey, 2011.
7. Government of Pakistan and UNICEF. National Nutrition Survey 2018. Key Findings Report [Internet]; June 2019 [cited 2020 June 30].52 p. Available from: https://www.unicef.org/pakistan/reports/national-nutrition-survey-2018-key-findings-report
8. Woldie H, Kebede Y, Tariku A. Factors associated with anemia among children aged 6–23 months attending growth monitoring at Tsitsika Health Center, Wag-Himra Zone, Northeast Ethiopia. Nutr Metab. 2015;2015:1-9. doi:10.1155/2015/928632
9. Abu-Ouf NM, Jan MM. The impact of maternal iron deficiency and iron deficiency anemia on child's health. Saudi Med J. 2015;36(2):146-9. doi:10.15537/smj.2015.2.10289
10. Al-Qaoud NM, Al-Shami E, Prakash P. Anemia and associated factors among Kuwaiti preschool children and their mothers. Alexandria J Med. 2015;51(2):161-6. doi:10.1016/j.ajme.2014.06.006
11. Roux AVD, Mair C. Neighborhoods and health.Ann NY Acad Sci. 2010;1186:125-45. doi:10.1111/j.1749-6632.2009.05333.x
12. Gordon-Larsen P. Food Availability/Convenience and Obesity. Am SocNutr. 2014;5(6):809–17. doi:10.3945/an.114.007070
13. Curioni C, Boclin K, Silveira I, Canella D, Castro I, Bezerra F, et al. Neighborhood food environment and consumption of fruit and leafy vegetables: Pro-Saude Study, Brazil. Public Health. 2020;182:7-12. doi:10.1016/j.puhe.2020.01.004
14. Saleem AF, Mahmud S, Baig-Ansari N, Zaidi AKM. Impact of maternal education about complementary feeding on their infants' nutritional outcomes in low- and middle-income households: A community-based randomized interventional study in Karachi, Pakistan. J Health Popul Nutr. 2014;32(4):623. PMID: 25895196
15. Huda M, Rabbani U, Rabbani F. Inculcating Health Awareness in Karachi, Pakistan: How innovative, socially acceptable methods can help combat communicable diseases of poverty. Int J Commun Res Engag. 2017;10:78-96. doi:10.5130/ijcre.v10i0.5481
16. Shakoor S, Ahmed I, Mukhtiar S, Ahmed I, Hirani F, Sultana S, et al. High heterotrophic counts in potable water and antimicrobial resistance among indicator organisms in two peri-urban communities of Karachi, Pakistan. BMC Res Notes. 2018;11(1):350. doi:10.1186/s13104-018-3461-z
17. Rose D, Richards R. Food store access and household fruit and vegetable use among participants in the US Food Stamp Program. Public Health Nutr. 2004;7(8):1081-8. doi:10.1079/PHN2004648
18. Bodor JN, Rose D, Farley TA, Swalm C, Scott SK. Neighbourhood fruit and vegetable availability and consumption: the role of small food stores in an urban environment. Public Health Nutr. 2008;11(4):413-20. doi:10.1017/S1368980007000493
19. Woodruff RC. Increasing community access to fresh fruits and vegetables: a case study of the Farm Fresh Market pilot program in Cobb County, Georgia, 2014. Prev Chronic Dis. 2016;13:150442. doi:10.5888/pcd13.150442
20. Ngnie-Teta I, Receveur O, Kuate-Defo B. Risk factors for moderate to severe anemia among children in Benin and Mali: insights from a multilevel analysis. Food Nutr Bull. 2007;28(1):76-89. doi:10.1177/156482650702800109
21. Dey S, Raheem E. A multilevel multinomial logistic regression model for identifying risk factors of anemia in children aged 6-59 months in northeastern states of India. arXiv preprint arXiv:1504.02835. 2015:1-20.
22. Ayana AB, Hailemariam TW, Melke AS. Determinants of acute malnutrition among children aged 6–59 months in Public Hospitals, Oromia region, West Ethiopia: a case–control study. BMC Nutr. 2015;1(1):34. doi:10.1186/s40795-015-0031-9
23. Sand A, Kumar R, Shaikh BT, Somrongthong R, Hafeez A, Rai D. Determinants of severe acute malnutrition among children under five years in a rural remote setting: A hospital based study from district Tharparkar-Sindh, Pakistan. Pak JMed Sci. 2018;34(2):260-5. doi:10.12669/pjms.342.14977
24. Dey S, Raheem E. Multilevel multinomial logistic regression model for identifying factors associated with anemia in children 6–59 months in northeastern states of India. Cogent Math Stat. 2016;3(1):1159798. doi:10.1080/23311835.2016.1159798
25. Ntenda PAM, Chuang K-Y, Tiruneh FN, Chuang Y-C. Multilevel analysis of the effects of individual-and community-level factors on childhood Anemia, severe Anemia, and

hemoglobin concentration in Malawi. J Trop Pediatrics. 2018;64(4):267-78. doi:10.1093/tropej/fmx059
26. Yusuf A, Mamun A, Kamruzzaman M, Saw A, El-fetoh NMA, Lestrel PE, et al. Factors influencing childhood anaemia in Bangladesh: a two level logistic regression analysis. BMC Pediatr. 2019;19(1):213-21. doi:10.1186/s12887-019-1581-9
27. Asresie MB, Fekadu GA, Dagnew GW. Determinants of anemia among children aged 6–59 months in Ethiopia: Further analysis of the 2016 Ethiopian demographic health survey. Adv Public Health. 2020;2020:1-6. doi:10.1155/2020/3634591
28. Gilmartin AA, Petri Jr WA. Exploring the role of environmental enteropathy in malnutrition, infant development and oral vaccine response. Philos T R Soc B. 2015;370(1671):20140143. doi:10.1098/rstb.2014.0143
29. Gwetu T, Chhagan M. Evaluation of the diagnostic accuracy of the HemoCue device for detecting anaemia in healthy school aged children in KwaZulu-Natal, South Africa. S Afr Med J. 2015;105(7):596-9.doi:10.7196/SAMJnew.7919
30. Bharati S, Pal M, Chakrabarty S, Bharati P. Socioeconomic determinants of iron-deficiency anemia among children aged 6 to 59 months in India. Asia Pac J Public He. 2015;27(2):NP1432-NP43. doi:10.1177/1010539513491417
31. Myszkowska-Ryciak J, Harton A. Implementation of dietary reference intake standards in preschool menus in poland. Nutrients. 2018;10(5):592-605. doi:10.3390/nu10050592