©

SNEHA®

SOCIETY FOR NUTRITION, EDUCATION AND HEALTH ACTION

Composite Index of Anthropometric Failure and its correlates: a cross-sectional study of under five children in an urban informal settlement of Mumbai, India

Manjula Bahuguna, Sushmita Das, David Osrin, Dr. Shanti Pantvaidya, Anuja Jayaraman

March 2021

Abstract

Introduction: The use of conventional anthropometric indices by malnutrition management programs may miss children with dual or multiple forms of growth failure. The Composite Index of Growth Failure (CIAF) helps to identify such vulnerable children

Objective: We aimed to assess the prevalence of undernutrition and its subgroups using the CIAF among children under five residing in urban informal settlements of Mumbai, India. We also examined the factors associated with undernutrition.

Methods: Data from a cross-sectional survey was used to construct CIAF; WHO Z-scores were used to categorize children into seven subgroups: (A) no failure, (B) wasting only, (C) wasting and underweight, (D) wasting, stunting, and underweight, (E) stunting and underweight, (F) stunting only, (G) underweight only. Undernutrition prevalence was assessed by combining all these subgroups except subgroup A. Factors associated with undernutrition were explored using multilevel logistic regression models adjusted for child, maternal and households socioeconomic characteristics.

Results: 3394 out of 6489 children (52.3%) were undernourished. Of these undernourished children, 37.2% had single anthropometric failure, 51.1% had dual anthropometric failures, and 11.6% had multiple anthropometric failures. Among all subgroups of undernourished children, “stunting and underweight” had the highest prevalence (44.2%). Child’s age, mother’s age and education, parity, type of toilet facility used, and household economic status were associated with undernutrition.

Conclusions: The CIAF can be used by nutrition programs to develop need-specific interventions to reduce the risk of aggravated morbidities and mortality. To improve child health and nutrition, Government programs should continue to focus on issues related to women’s education and early pregnancies.

Keywords: Malnutrition, Child Health, Community-based nutrition program, Composite Index of Anthropometric Failure, Urban Health, India

Introduction

Malnutrition is one of the major underlying causes of preventable child deaths worldwide [1-3]. In low and middle-income countries approximately 45% of all child deaths can be attributed to poor nutrition [4]. The Global Nutrition Report (2018) suggests that India has the most children with stunting (46.6 million) and wasting (25.5 million) [5]. Maharashtra, one of the most urbanized states in the country, has the highest proportion of people living in slums (18.1%), characterized by overcrowding, unhealthy living conditions, lack of basic facilities, poverty and social exclusion [6]. Children under five years of age living in slums are at higher risk of poor health than children living in non-slum areas [7]. They are particularly vulnerable to recurrent infections and malnutrition, which have long-term effects on cognitive development [8].

Malnutrition management programs use anthropometric screening to assess growth patterns and nutritional status, to identify individuals at risk, to customize nutritional counselling, and to make appropriate referrals [9]. India's National Family Health Survey uses World Health Organization indices - low weight for age (underweight), low height for age (stunting) and low weight for height (wasting) - to assess undernutrition among children under five [10]. The Integrated Child Development Services (ICDS), India's foremost early childhood care and development program, uses underweight for anthropometric screening and provides supplementary nutrition to undernourished children in communities [11]. Development economist Peter Svedberg suggested that conventional indices might be insufficient as a measure of prevalence of child undernutrition due to indices overlapping; a child who is underweight may also be stunted and/or wasted. Svedberg proposed an alternative indicator, the Composite Index of Anthropometric Failure (CIAF), to categorise children into six subgroups according to wasting, stunting and underweight status [12]. The CIAF was later modified to include another subgroup of children who were only underweight [13].

A UNICEF, WHO and World Bank Group report on levels and trends in child malnutrition also suggests that some children suffer from more than one form of malnutrition and currently there are no global or regional estimates for such children [14]. Nandy *et al.* (2005) suggested that children with dual anthropometric failure were more likely to have diarrhoea than single anthropometric failure and children who were simultaneously wasted, stunted and underweight had the highest odds of having diarrhoea and acute respiratory infections [13]. Mcdonald *et al.* (2013) suggest that children with dual anthropometric failure were at a heightened risk of mortality and children with all three anthropometric failures had a 12-fold elevated risk of mortality [15].

In a single classification, the CIAF gives a comprehensive picture of the scale of undernutrition and can help to identify the type of intervention required for the most prevalent subgroup in the community. In India, a few studies have assessed undernutrition prevalence using the CIAF and a few have also studied associated factors such as child age and sex, socioeconomic status, maternal education, birth order, birth intervals, exclusive breastfeeding, childhood morbidities, and number of siblings [16-20].

Our study aimed to establish the overall extent of undernutrition along with its associated factors, using the CIAF in urban informal settlements of Mumbai. The objectives were (1) to assess the prevalence of undernutrition and its subgroups using the CIAF in children aged 0-59 months residing in urban informal settlements of Mumbai, and (2) to determine the association of undernutrition with child, maternal and household socioeconomic characteristics.

Methods

Study setting, program description and participants:

In 2011, a randomized control trial was initiated in urban informal settlements of Mumbai. 40 areas (20 control, 20 intervention) of M-East ward (HDI 0.05) and L ward (HDI 0.29); wards with lowest human development index, were chosen for intervention [21]. Each intervention areas had a community resource centre to provide community-level access to a range of services related to health, nutrition, and safety to women and children. Married women of reproductive age (15-49 years) and children (0-5 years) were the primary beneficiaries. Key intervention activities were growth monitoring through monthly anthropometric screening, regular home visits to provide information on family health needs and appropriate referrals, day-care centres for early childhood care and development activities for severely malnourished children, service provision by clinicians and counsellors, group meetings and community events to create a conducive environment for women's and children's health.

Data source: We used the trial's post-intervention census data collected between February 2014 and September 2015. In each household, the youngest married woman of reproductive age (15-49 years) was interviewed to obtain information on socioeconomic status, household characteristics, obstetric history, family planning practices and uptake of health services. Anthropometric data of all children in census were collected by measuring height/length and weight. Lengths of children younger than two years were measured with a Rollameter accurate to 1mm with an assistant holding the child's head. Heights of children aged two years and older were measured with a Leicester stadiometer accurate to 1 mm, at the end of expiration with feet together against the backboard, back straight, and head in the Frankfort plane. Weights were measured with Seca 385 electronic scales accurate to 10g. Training for data collectors was repeated on two occasions, for which the indicative technical errors of measurement for height were 0·6%, and 0·5% [22].

Study variables: Nutritional status was assessed by both conventionally used undernutrition indices (wasting, stunting, underweight) and CIAF. Age- and sex-specific weight-for-age Z scores (WAZ), height-for-age Z scores (HAZ) and weight-for-height Z scores (WHZ) were generated using World Health Organization growth standards and the Z SCORE06 module in Stata/IC (version 13.1). Following Nandy *et al.* 2005, CIAF was constructed using Z-scores to categorize children into seven subgroups: (A) no failure, (B) wasting only, (C) wasting and underweight, (D) wasting, stunting, and underweight, (E) stunting and underweight, (F) stunting only, and (G) underweight only [13]. Based on the CIAF, a child was considered undernourished if they had any form of anthropometric failure.

Data Analysis: Factors associated with undernutrition in children (0-59 months) were explored using multilevel logistic regression model adjusting for child, maternal and socioeconomic characteristics of the household. Independent variables with p <0.25 in bivariate analysis were included in the final regression model. These included child's age, mother's age, religion, education, length of residence in Mumbai, parity, exposure to violence, uptake of health services, number of household residents, source of drinking water, type of toilet facilities, and asset index quartile. For each explanatory variable, the crude odds ratio was presented along with the adjusted odds ratio (AOR) and 95% confidence intervals (CI). All analysis was conducted in STATA 12.0 (StataCorp, College Station, TX).

Ethical statement

The study received ethical approval from the Multi-Institutional Ethics Committee of the Anusandhan Trust, Mumbai, India, in sequential reviews: formative research (February, 2011), cluster vulnerability (May, 2011), the pre intervention census (August, 2011), and the intervention and assessments (January, 2012). It was also approved by the University College London Research Ethics Committee, UK, in January, 2012 (reference 3546/001).

Results

Post-intervention census data were collected from 24,939 households. 16,236 married women aged 15-49 years were interviewed including 7601 women with 10,551 children under age five. A total of 6489 children under age five were included in the analysis for this study, as seen in Figure 1.

Figure 1: Study profile

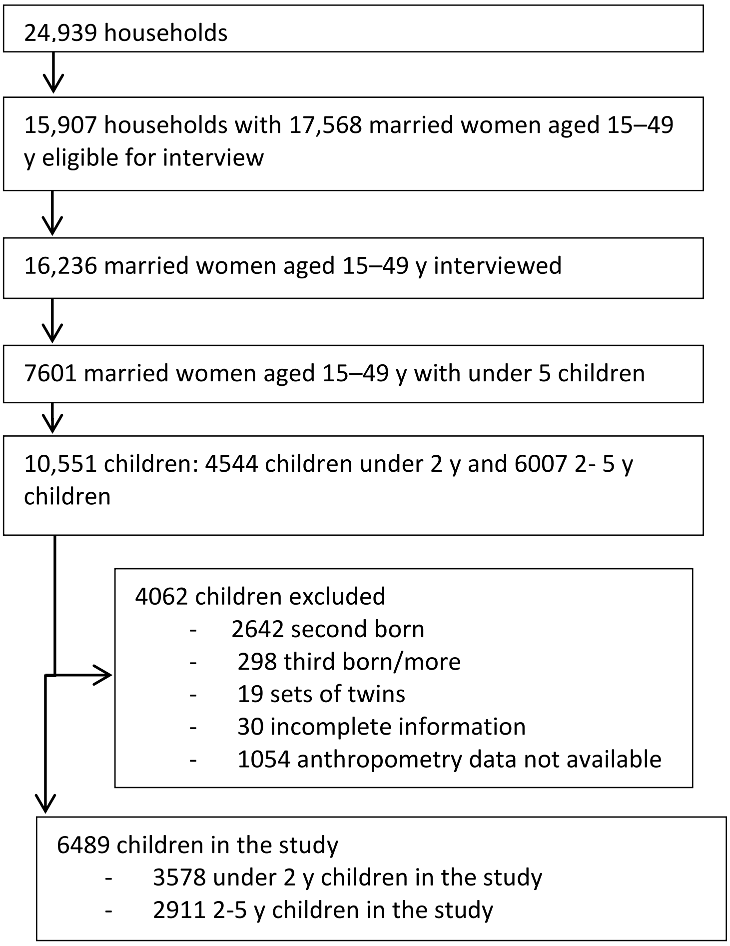

Table 1 presents the prevalence of child undernutrition. Based on the CIAF classification, more than half of the children were undernourished.

Table 1: Prevalence of undernutrition as per CIAF classification

CIAF classification		n	%
Group A	No failure	**3095**	**47.7**
Group B	Wasting only	**109**	**1.7**
Group C	Wasting and underweight	**237**	**3.7**
Group D	Wasting, stunting, and underweight	**393**	**6.0**
Group E	Stunting and underweight	**1499**	**23.1**
Group F	Stunting only	**963**	**14.8**
Group Y	Underweight only	**193**	**3.0**
Total		**6489**	**100.0**

Undernutrition (Group B + Group C + Group D + Group E + Group F + Group Y) = 52.3%

Conventional indices of undernutrition showed 11.4% wasting, 35.7% underweight and 44.0% stunting. Conventional wasting includes children of CIAF groups B, C, and D, but omits the 40.9% of children of groups E, F, and Y. Conventional underweight includes children of CIAF groups C, D, E, and Y, but omits the 16.5% of children of groups B and F. Conventional stunting includes children of CIAF groups D, E, and F, but omits the 8.3% of children of groups B, C, and Y.

Table 2 presents frequencies and proportions of respondent characteristics, along with prevalence of CIAF growth failure for each characteristic.

Table 2: Child, maternal, socioeconomic characteristics and proportionate undernutrition prevalence

	CIAF no failure N=3095		**CIAF failure N=3394**		**Total N=6489**	
Child Characteristics						
Age	**n**	**%**	**N**	**%**	**n**	**%**
Less than 2 years	1928	62.3	1650	48.6	3578	55.1
2-5 years	1167	37.7	1744	51.4	2911	44.8
Sex						
Male	1575	50.9	1772	52.2	3347	51.6
Female	1520	49.1	1622	47.8	3142	48.4
Maternal Characteristics						
Age						
Less than 25 years	840	27.1	883	26.0	1723	26.5
25-29 years	1216	39.3	1302	38.4	2518	38.8
30 years or above	1039	33.6	1209	35.6	2248	34.6
Religion						
Muslim	2605	84.2	2820	83.1	5425	83.6
Hindu	484	15.6	568	16.7	1052	16.2
Other	6	0.2	6	0.2	12	0.18
Education						
Illiterate	764	24.7	1080	31.8	1844	28.4
Primary (grades 1-4)	142	4.6	192	5.7	334	5.1
Secondary (grades 5-10)	1867	60.3	1880	55.4	3747	57.7
Higher (grade 11 or higher)	322	10.4	242	7.1	564	8.7
Length of stay in Mumbai						
<=1 year	293	9.5	359	10.5	652	10.7
2-5 years	608	19.6	652	19.2	1260	20.8
6-10 years	492	15.9	537	15.8	1029	16.9
>10 years	1501	48.5	1625	47.9	3126	51.5
Missing	201	6.5	221	6.5	422	0.06
Parity						
3 or more children	1413	45.7	1732	51.0	3145	48.5
1 or 2 children	1682	54.3	1662	49.0	3344	51.5
Exposure to spousal violence in last 2 years						
No	2754	89.0	2964	87.3	5718	88.1
Yes	341	11.0	429	12.6	770	11.9
Missing	0	0.0	1	0.0002	1	0.0001
Uptake of health services in last 1 year						
None	892	28.8	995	29.3	1887	29.0
Only government (ICDS/BMC)	824	26.6	832	24.5	1656	25.5
Community resource centre	643	20.8	736	21.7	1379	21.2
Both	736	23.8	831	24.5	1567	24.1

Socio-economic characteristics						
Number of household members						
Less than or 5	1612	52.1	1735	51.1	3347	51.6
5 or more	1483	47.9	1659	48.9	3142	48.4
Drinking water source						
Public	2295	74.1	2688	79.2	4983	76.8
Private	800	25.9	706	20.8	1506	23.2
Type of toilet facility						
Public	2451	79.2	2890	85.1	5341	82.3
Private	644	20.8	504	14.9	1148	17.7
Asset index quartile						
1 (Poorest)	752	24.3	1009	29.7	1761	27.1
2	680	22.0	874	25.8	1554	23.9
3	807	26.0	784	23.1	1591	24.5
4 (Least poor)	856	27.7	727	21.4	1583	24.4

Factors associated with undernutrition: The results of multivariable logistic regression suggest that child's age, mother's age, her education, parity, type of toilet facility and economic status were associated with undernutrition. Table 3 shows that children in the age group 2-5 years had higher odds [AOR 1.93, 95% CI 1.72, 2.15] of being undernourished than children less than two years old. Older mothers (>=30years) had lower odds [AOR 0.73, 95% CI 0.62, 0.86] of having undernourished children than mothers below 25 years of age. Compared with children of women with no education, children of women with secondary [AOR 0.78, 95% CI 0.69, 0.89] or higher education [AOR 0.67, 95% CI 0.54, 0.84] were less likely to be undernourished. Women with one or two children had lower odds [AOR 0.83, 95% CI 0.72, 0.94] of having an undernourished child than women with three or more children. Households using private toilets were less likely [AOR 0.78, 95% CI 0.66, 0.91) to have undernourished children than households using public toilets. Children living in less poor [AOR 0.75, 95% CI 0.64, 0.87] or wealthier [AOR 0.71, 95% CI 0.59, 0.84] households had lower odds of being undernourished than children residing in poorer households.

Table 3: Factors associated with undernutrition

Child Characteristics	**Crude odds ratio (95% CI)**	**Adjusted odds ratio (95% CI)**
Age		
Less than 2 years	1	1
2-5 years	1.74 (1.58, 1.92)	1.93 (1.72, 2.15) ***
Sex		
Male	1	1
Female	0.94 (0.86, 1.04)	0.96 (0.86, 1.06)
Maternal Characteristics		
Age		
Less than 25 years	1	1
25-29 years	1.01 (0.90, 1.15)	0.81 (0.71, 0.94) **
30 years or above	1.10 (0.97, 1.25)	0.73 (0.62, 0.86) ***
Religion		
Muslim	1	1
Hindu	1.08 (0.94, 1.23)	1.14(0.99, 1.32) *
Education		
Illiterate	1	1
Primary (grades 1-4)	0.95 (0.75, 1.21)	0.90 (0.70, 1.16)
Secondary (grades 5-10)	0.71 (0.63, 0.79)	0.78 (0.69, 0.89) ***
Higher (grade 11 or higher)	0.53 (0.43, 0.64)	0.67 (0.54, 0.84) ***

Length of stay in Mumbai		
<=1 year	1	1
2-5 year	0.87 (0.72, 1.05)	1.0 (0.81, 1.22)
6-10year	0.89 (0.73, 1.08)	0.93 (0.75, 1.15)
>10year	0.88 (0.74, 1.04)	0.99 (0.82, 1.20)
Parity		
3 or more children	1	1
1or 2 children	0.80 (0.73, 0.88)	0.83 (0.72, 0.94) **
Exposure to spousal violence in last 2 years		
No	1	1
Yes	1.16 (1.0, 1.35)	1.11 (0.94, 1.30)
Uptake of health services in last 1 year		
None	1	1
Government (ICDS/BMC)	0.90 (0.79, 1.03)	1.05 (0.91, 1.22)
Community resource centre	1.02 (0.89, 1.17)	1.06 (0.91, 1.23) *
Both	1.01 (0.88, 1.15)	1.21 (1.04, 1.40)
Socio-economic characteristics		
Number of household members		
Less than or 5	1	1
More than 5	1.03 (0.94, 1.14)	1.13 (1.00, 1.26) *
Drinking water source		
Public	1	1
Private	0.75 (0.67, 0.84)	0.92 (0.80, 1.07)
Type of toilet facility		
Public	1	1
Private	0.66 (0.58, 0.75)	0.78 (0.66, 0.91) **
Asset index quartile		
1(Poorest)	1	1
2	0.95 (0.83, 1.09)	0.97(0.84, 1.13)
3	0.72 (0.63, 0.82)	0.75(0.64, 0.87) ***
4 (Least poor)	0.63 (0.55, 0.72)	0.71(0.59, 0.84) ***

"Statistical significance is calculated using mixed effects logistic regression models: * p value: ≤0.05; * * p value: ≤0.01; *** p value: ≤0.001"

Discussion

Undernutrition prevalence was higher as per CIAF, which can be attributed to the ability of CIAF to count children with dual and multiple anthropometric deficits. Recent studies have assessed undernutrition prevalence using the CIAF as 48.5% in Ethiopia, 21.7% in rural China and 47.9% in urban Bangladesh [23-25]. In India, studies from different states used CIAF to estimate undernutrition prevalence and report a higher prevalence as compared to our study. According to various studies from West Bengal, undernutrition prevalence ranged from 57.6% to 73.1%, much higher than in our study [16, 17, 26-28]. Jammu and Kashmir (73.2%), Gujarat (60.5%), Chhattisgarh (62.1%), and Orissa (54.5%) also had higher undernutrition prevalence than observed in our study [20, 29-31]. In Nagpur, Maharashtra, 51% of children were reported to be undernourished which was similar to that in our study and in the western suburbs of Mumbai undernutrition prevalence was 47.8%, lower than that of our study [18, 32].

Our study found 6% of children had all three forms of anthropometric failure, which is less than the corresponding prevalence in the study by Savanur *et al.* 2015 conducted in the western suburbs of Mumbai, suggesting that 8.2% of children suffered simultaneously from wasting, stunting and underweight. We found that among all groups of CIAF, group E, "Stunting and underweight," had the highest prevalence (23.1%), which is similar to the study done in the western suburbs of Mumbai that reported the stunting and underweight prevalence as the highest (16.1%) [32]. Our study showed that by using weight-for-age criteria, we missed 16.5% of children who were considered undernourished using other indices, which is similar to other studies missing 12.1% to 21.9% of undernourished children [33-35]. Failure to identify these children could have consequences including increased morbidity and mortality [13, 15].

Our study found that as the age of the child increases, the risk of undernutrition increases, a finding consistent with the studies conducted in India [16, 19] and Ethiopia [23]. Our study found that young mothers were at greater risk of having undernourished children, which is consistent with the studies suggesting linear growth failure in children of teenage mothers [36, 37]. The negative association found between level of maternal education and child undernutrition was consistent with other studies in India [16-18], Ethiopia [23], China [24], and Bangladesh [25]. This may be because mothers with higher education are most likely to follow healthy practices while taking decisions about their child's health [38-40]. The association between parity and undernutrition is similar to the studies suggesting that children with more than three siblings are at higher risk of being undernourished [17-20]. In addition, our study found a statistically significant association between use of public toilets and undernutrition, which may be due to environmental enteropathy caused by living in poor and unhygienic conditions [41, 42]. This, however, needs to be interpreted carefully considering recent WASH trials [43, 44]. We found that children of poor socioeconomic status were at greater risk of undernutrition, which is consistent with studies from Ethiopia [23], China [24], Bangladesh [25] and India [18, 19].

CIAF has its limitations similar to conventional anthropometric indices. Anthropometric indices are used as proxy indicators for undernutrition among children and do not distinguish between different underlying causes such as illness versus purely poor nutrition. CIAF may overestimate the undernutrition prevalence by including children with anthropometric failure due to the outcome of diseases and other non-nutrition related factors [12]. These indices also do not identify specific nutritional deficiencies, which should be assessed through other methods like biochemical, clinical and dietary assessment [9]. Our study did not consider variables such as children's diet and morbidity which may have confounding effect on the results. Finally, the association between undernutrition and its correlates was based on cross-sectional data and cannot be used to establish a causal relationship.

Conclusion

More than half of children in the age group 0-5 years were suffering from one or the combined forms of anthropometric failure. Children having young and uneducated mothers, with siblings, using public toilets and from poor socioeconomic backgrounds were at greater risk of falling into any category of anthropometric failure. Therefore, government programs should continue to focus on improving women education and early pregnancies among women in urban areas. Malnutrition management programs often use conventional anthropometric indices separately which prevents the identification of the subgroup of children who are at greatest risk with dual or multiple anthropometric deficits. We recommend the use of the CIAF to identify these vulnerable children for better coverage of services to improve their health and nutritional status. Each category needs specific interventions - not one size that fits all. Given the limited resources, drawing these finer distinctions will not only help in further reduction of undernutrition but will help in prioritizing interventions for children with multiple anthropometric failure to reduce the risk of aggravated morbidities and mortalities. Our findings further support the advocacy of taking length/height measurement of children by the ICDS and thereby improve the precision by which this agency identifies nutritionally vulnerable children.

Acknowledgements

We are very grateful to the women and their families who made this study possible by allowing us into their homes to interview them. We thank the entire intervention staff for implementation of the program operations. We are thankful to the field investigators for data collection and field officers for supervision. We thank Neena Shah More for reviewing the paper and Latika Bhosale and Laxmi Solanki for data management. We are thankful to Archana Bagra, Vanessa D'Souza and members of SNEHA Research Group.

References

1. Rice AL, Sacco L, Hyder A, Black R. Malnutrition as an underlying cause of childhood deaths associated with infectious diseases in developing countries. Bull World Health Organ. 2000; 78(10):1207-21.
2. Caulfield LE, de Onis M, Blossner M, & Black RE. Undernutrition as an underlying cause of child deaths associated with diarrhea, pneumonia, malaria, and measles. Am J Clin Nutr. 2004;80(1):193–198.
3. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2003;361(9376):2226–2234.
4. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet. 2013;382(9890):427–451.
5. Global Nutrition Report. Chapter 02: The burden of malnutrition. 2018. https://globalnutritionreport.org/reports/global-nutrition-report-2018/burden-malnutrition/#section-2-4. Accessed 15 July 2019.
6. Government of India, Ministry of Housing and Urban Poverty Alleviation: National Buildings Organisation. Slums in India: A Statistical Compendium 2015. 2015. http://nbo.nic.in/Images/PDF/SLUMS_IN_INDIA_Slum_Compendium_2015_English.pdf. Accessed 19 Feb 2019.
7. Agarwal S. The state of urban health in India; comparing the poorest quartile to the rest of the urban population in selected states and cities. Environment and Urbanization. 2011;23(1):13–28.
8. Ezeh A, Oyebode O, Satterthwaite D, Chen YF , Ndugwa R, Sartori J. The history, geography, and sociology of slums and the health problems of people who live in slums. Lancet. 2017;389(10068):547–558.
9. Cashin K, Oot L. Guide to Anthropometry: A Practical Tool for Program Planners, Managers, and Implementers. Washington, DC: Food and Nutrition Technical Assistance III Project (FANTA)/ FHI 360. 2018. https://www.fantaproject.org/sites/default/files/resources/FANTA-Anthropometry-Guide-May2018.pdf. Accessed 15 July 2019.
10. International Institute for Population Sciences (IIPS) and ICF (2017) National Family Health Survey (NFHS-4), 2015-16: India. Mumbai: IIPS. http://rchiips.org/nfhs/NFHS-4Reports/India.pdf. Accessed 15 July 2019.
11. Integrated Child Development Scheme Ministry of Women and Child Development, Government of India, https://icds-wcd.nic.in/. Accessed on 1 April 2019
12. Svedberg P. Poverty and Undernutrition: Theory, Measurement, and Policy. Oxford University Press. 2000.
13. Nandy S, Irving M, Gordon D, Subramanian SV, Smith GD. Poverty, child undernutrition and morbidity: new evidence from India. Bull World Health Organ. 2005;83:210–216.
14. United Nations Children's Fund (UNICEF), World Health Organization, International Bank for Reconstruction and Development/The World Bank. Levels and trends in child malnutrition: key findings of the 2019 edition of the Joint Child Malnutrition Estimates. Geneva: World Health Organization; 2019. https://data.unicef.org/wp-content/uploads/2019/04/Joint-malnutrition-estimates-March2019-1.pdf. Accessed 15 July 2019.
15. McDonald CM, Olofin I, Flaxman S, Fawzi WW, Spiegelman D, Caulfield LE, et al. The effect of multiple anthropometric deficits on child mortality: meta-analysis of individual data in 10 prospective studies from developing countries. Am J Clin Nutr. 2013;97:896–901.
16. Dasgupta A, Sahoo SK, Taraphadar P, Preeti P, Biswas DM, Kumar A, et al. Composite index of anthropometric failure and its important correlates: a study among under-5 children in a slum of Kolkata, West Bengal, India. Int J Med Sci Public Health. 2015;4:414-419.
17. Shit S, Taraphdar P, Mukhopadhyay D, Sinhababu A, Biswas A. Assessment of nutritional status by composite index for anthropometric failure: A study among slum children in Bankura, West Bengal. Indian J Public Health. 2012;56:305-307.
18. Dhok RS, Thakre SB. Measuring undernutrition by composite index of anthropometric failure (CIAF): a community-based study in a slum of Nagpur city. Int J Med Sci Public Health. 2016;5:2013-2018.
19. Kherde A, Patil C , Deshmukh JS, Petkar PB. Composite index of anthropometric failure among under 5 children attending the Immunoprophylaxis clinic in a tertiary care hospital in Nagpur, Maharashtra, India. Int J Contemp Pediatr. 2018;5:888-892.
20. Dewan D, Kumar D, Gupta R. Predictors of anthropometric failure among under five slum children of Jammu, India. Int J Community Med Public Health. 2016;3:1059-1964.
21. Municipal Corporation of Greater Mumbai. Mumbai Human Development Report 2009. Oxford University

Press. 2010. http://www.indiaenvironmentportal.org.in/files/Mumbai%20HDR%20Complete.pdf. Accessed 15 July 2019.
22. More NS, Das S, Bapat U, Alcock G, Manjrekar S, Kamble V, et al. Community resource centres to improve the health of women and children in informal settlements in Mumbai: a cluster-randomised, controlled trial. Lancet Glob Health. 2017;5:e335–e349.
23. Endris N, Asefa H, Dube L. Prevalence of Malnutrition and Associated Factors among Children in Rural Ethiopia. BioMed Research International. 2017;2017: Article ID 6587853, 6 pages.
24. Pei L, Ren L, Yan H. A survey of undernutrition in children under three years of age in rural Western China. BMC Public Health. 2014;14:121.
25. Khan REA, Raza MA. Nutritional Status of Children in Bangladesh: Measuring Composite Index of Anthropometric Failure (CIAF) and its Determinants its Determinants. Pak J Commer Soc Sci. 2014;8:11-23.
26. Das S, Bose K. Report on "anthropometric failure" among rural 2-6 years old Indian Bauri caste children of West Bengal. Anthro Rev. 2009;72: 81–88.
27. Mandal GC, Bose K. Assessment of Overall Prevalence of Undernutrition Using Composite Index of Anthropometric Failure (CIAF) among Preschool Children of West Bengal, India. Iran J Pediatr. 2009;19:237–243
28. Biswas S, Giri SP, Bose K. Assessment of nutritional status by composite index of anthropometric failure (CIAF): a study among preschool children of Sagar Block, South 24 Parganas District, West Bengal, India. Anthro Rev. 2018;81:269–277.
29. Solanki R, Patel T, Shah H, Singh US. Measuring Undernutrition Through Z-Scores and Composite Index of Anthropometric Failure (CIAF): a Study Among Slum Children in Ahmedabad City, Gujarat, Natl J Community Med. 2014;5:434–439.
30. Boregowda GS, Soni GP, Jain K, Agrawal S. Assessment of under nutrition using composite index of anthropometric failure (CIAF) amongst toddlers residing in urban slums of Raipur City, Chhattisgarh, India. J Clin Diagn Res. 2015;9:LC04-LC06.
31. Goswami M. Prevalence of Under-Nutrition Measured by Composite Index of Anthropometric Failure (CIAF) Among the Bhumij Children of Northern Odisha, India. J Nepal Paediatr Soc. 2016;36:61-67.
32. Savanur MS, Ghugre PS. Magnitude of undernutrition in children aged 2 to 4 years using CIAF and conventional indices in the slums of Mumbai city. J Health Popul Nutr. 2015;33.
33. Nandy S, Miranda JJ. Overlooking undernutrition? Using a composite index of anthropometric failure to assess how underweight misses and misleads the assessment of undernutrition in young children. Soc Sci Med. 2008;66:1963–1966.
34. Seetharaman N, Chacko TV, Shankar SLR, Mathew AC. Measuring malnutrition -The role of Z scores and the composite index of anthropometric failure (CIAF). Indian J Community Med. 2007;32:35-39.
35. Anjum F, Pandit MI, Mir AA, Bhat IA. Z Score and CIAF - A comprehensive measure of magnitude of undernutrition in a rural school going population of Kashmir, India. Glob J Med and Public Health. 2012;1:46–49
36. Yu SH, Mason J, Crum J, Cappa C, Hotchkiss DR. Differential effects of young maternal age on child growth. Glob Health Action. 2016;9:31171.
37. Wemakor A, Garti H, Azongo T, Garti H, Atosona A. Young maternal age is a risk factor for child undernutrition in Tamale Metropolis, Ghana. BMC Research Notes. 2018;11:877.
38. Badji S. Mother's Education and Increased Child Survival in Madagascar: What Can We Say? SSRN. 2016.
39. Gupta MD. Death Clustering, Mothers' Education and the Determinants of Child Mortality in Rural Punjab, India. Population Studies. 1990;44:489–505.
40. Mondal RK, Majumder M, Rayhan SJ. The Impact of Maternal Education on Child Health; Evidence from Bangladesh. Asian J Social Sciences & Humanities. 2014;3:19-27.
41. Korpe PS, Petri WA Jr. Environmental enteropathy: critical implications of a poorly understood condition. Trends Mol Med. 2012;18:328–336.
42. Mbuya MN, Humphrey JH. Preventing environmental enteric dysfunction through improved water, sanitation and hygiene: an opportunity for stunting reduction in developing countries. Matern Child Nutr. 2016;12:106–120.
43. Luby SP, Rahman M, Arnold BF, Unicomb L, Ashraf S, Winch PJ, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Bangladesh: a cluster

randomised controlled trial. Lancet Glob Health. 2018;6:e302–e315.
44. Null C, Stewart CP, Pickering AJ, Dentz HN, Arnold BF, Arnold CD, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial. Lancet Glob Health. 2018;6:e316–e329.