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RESEARCH ARTICLE

Mother's education level is associated with anthropometric failure among 3- to 12-year-old rural children in Purba Medinipur, West Bengal, India

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Abstract

Maternal education plays a central role in children's health and nutrition. Living conditions and socioeconomic status are linked with mother's education, which in turn determines the health and development of a child. The Composite Index of Anthropometric Failure (CIAF) is a single indicator that reflects overall rate of three conventional indices of undernutrition: underweight, stunting and wasting. The study was undertaken among 621 rural Bengalee children (308 boys and 313 girls) aged 3–12 years from the Purba Medinipur district of West Bengal, India. Height (cm) and weight (kg) were recorded and NCHS standard values used to calculate *z*-scores (<–2SD). The same data were used to calculate CIAF as an indicator of 'anthropometric failure' (AF) or undernutrition. The prevalence of AF among the children was 59.40%. Chi-squared analysis was employed to evaluate the significance of differences in the prevalence of CIAF between the sexes and the association between nutritional indicators and socioeconomic parameters in the two sexes. Multiple binary logistic regression (MBLR) analyses (including the forward stepwise method) were also performed. Odds ratios with 95% confidence intervals were used to assess the risk of having AF. Results showed that mother's education was significantly associated with undernutrition (AF) controlling for the other factors considered. A very high prevalence of undernutrition is persisting in this region of India despite national nutritional supplementation programmes being operational. More attention to the improvement of living conditions and hygiene, and more particularly the education of women, in this population might be effective in attaining improved child growth and health.

Keywords: Anthropometric failure; CIAF; Mother's education

Introduction

India has an enormous burden of undernutrition – a major public health problem that increases premature mortality and morbidity during childhood (UNICEF, 2019). Globally, undernutrition causes about 3.1 million child deaths annually (Black *et al.*, 2013; IFPRI, 2016; Ramesh *et al.*, 2017).

Anthropometry is a reliable, non-invasive, inexpensive and easily measurable method to assess nutritional status in adults and children (Kuczmarski *et al.*, 2002). The three most conventional anthropometric indicators of undernutrition in children are stunting (low height-for–age), wasting (low weigh-for-height), underweight (low weight-for-age) and thinness (low body mass index [BMI]-for-age) (WHO, 2006). The most recent National Family Health Survey (NFHS-4) reported that in India in 2015–16, 35.7%, 38.4% and 28.5% children were underweight, stunted and wasted, respectively, and that there were 34.0% stunted, 21.6% wasted and 33.6% underweight children under 5 years of age in rural areas of West Bengal (IIPS, 2017). However, these different indicators are considered to represent different aspect of nutritional conditions. Stunting represents the long-term cumulative effect of poor nutrition or infection since birth or during prenatal growth; wasting indicates a combined effect of chronic and acute malnutrition; underweight and low BMI-for-age reflect acute conditions, and are associated with an increased risk of mortality (WHO, 2010). However, estimates of these indicators in a population overlap and thus separate values for each condition cannot give an overall estimate of the undernourished state of children in a population. Besides, it is sometimes difficult to choose one of these as the best indicator. Moreover, these parameters also show different patterns of association with independent factors (Ahmadi *et al.*, 2018).

To address these issues, in the year 2000, the Swedish economist Peter Svedberg first suggested an alternative single indicator, namely, the Composite Index of Anthropometric Failure (CIAF), to determine the state of undernutrition, including all three conventional indicators (Svedberg, 2000; Nandy *et al.*, 2005). Use of a single criterion, such as wasting, might miss individuals who are also nutritionally vulnerable; CIAF identifies all of them under one umbrella as 'anthropometric failure' (AF) and provides an overall estimate of the undernourished state in children. This is why the prevalence rate determined with CIAF is often higher than that obtained using one of the conventional indicators. There have been numerous previous studies, including many recent ones, that has assessed nutritional status among children using the three conventional indices of stunting, wasting and underweight (Sen *et al.*, 2011; Ray & Chandra, 2013; Mandal *et al.*, 2014; Mansur *et al.*, 2015; Pramanik *et al.*, 2015; Chellamma *et al.*, 2017; Giri *et al.*, 2017; Abbasi *et al.*, 2018; Elema, 2018). Nevertheless, many studies also used CIAF for nutritional assessment among Indian children (Sen *et al.* 2011; Acharya *et al.*, 2013; Ramesh *et al.*, 2017; Roy *et al.*, 2018).

It has long been recognized that socioeconomic factors and living conditions, such as poverty, education, gender inequality, drinking water facility and household sanitation, are important determinants of health outcomes in low-income countries (CSDH, 2018). The nutritional status of children has been shown to be significantly affected by socioeconomic factors, including parental occupation and education, household socioeconomic status, number of people in a household and location of residence (urban/rural) (Sunil *et al.*, 2009; Emina *et al.*, 2011). Poor socioeconomic conditions and other demographic situations have been shown to play a significant role the prevalence of undernutition (Meshram *et al.*, 2012; Arora *et al.*, 2014; Rengma *et al.*, 2016; Sarkar, 2016; Yadav *et al.*, 2016; Ramesh *et al.*, 2017; Pal *et al.*, 2017). Poor quality of drinking water and adverse hygiene practices also play roles in increasing health risks and may in turn contribute to the burden of undernourished conditions (Teshome *et al.*, 2009), whereas improvement in hygiene practices has been shown to be associated with a reduction of stunting (Fenn *et al.*, 2012). Dearden *et al.* (2017), in their study in Ethiopia, found that children with access to improved sanitation, e.g. appropriate toilet facilities, had a lower rate of stunting than those who defecated in the open.

Mother's education has been found to be closely associated with several factors linked to child health and nutrition (Kraamwinkel *et al.*, 2019; Vikram & Vanneman, 2019). Women are generally the primary care-givers in the home and decision-makers on their children's health, and generally devote more time to the protection and care of children than men (Caldwell, 1993; Frost *et al.*, 2005; Akresh *et al.*, 2012). One of the most commonly explored links between maternal education and child health is socioeconomic status (Owoaje *et al.*, 2014). Women's education, in particular, may positively influence child health by increasing women's decision-making power within the family (Shafiq *et al.*, 2019). It has been reported in previous studies from different parts of the world that mother's education has a significant effect on the nutritional status of children (Handa *et al.*, 1999; Frost *et al.*, 2005; Abuya *et al.*, 2012).

The use of CIAF to provide a more 'overall' estimate of undernourishment, along with its socioeconomic and demographic determinants, has so far not been much studied – especially mother's educational status (Endris *et al.* 2017). This is particularly the case for populations where children

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are suffering from a very high prevalence of undernutrition, such as in India. The present study was conducted to assess the effects of these factors in a population of India where variations in socioeconomic factors like parental education, income and occupation are not very high, as is the case in rural areas. The objectives of the study were to assess the prevalence of CIAF among rural children in an East Indian district and the association of CIAF with socioeconomic and demographic characteristics, with special emphasis on mother's education.

Methods

Subjects and settings

This community-based, cross-sectional study was part of a larger study conducted between December 2014 and April 2016 in an urban industrial area (Haldia) and adjacent rural areas of Purba Medinipur district, West Bengal, India. According to NFHS-4, in Purba Medinipur district 75.2% of women were literate, 66.7% of households had proper sanitary facilities and 6.6% of households used clean fuel for cooking in 2015–16. The survey also reported that 7.1% children were suffering from diarrhoea and 52.6% from symptoms of acute respiratory infections (IIPS, 2017). The present study included rural children belonging to three villages (Kultalia, Sikdarchak and Uttar Amtalia) under the jurisdiction of a bigger administrative unit (*Gram Panchayat* or GP) called Amtalia, under the developmental block Contai-II. These three closely situated villages were the furthest, and most remote, in the particular rural segment of the Block, situated on the bank of the Rosulpur River, a tributary of the Hoogly River. The villages are inhabited by the Bengalee population who are Hindu by religion and belong to several caste groups. As previous studies have not found any significant differences in the anthropometric characteristics of the different castes of Bengalees, they can be pooled into a single group, namely 'Bengalee' (Biswas *et al*., 2011; Bhadra *et al*., 2013).

Participants were selected through door-to-door visits employing a combination of opportunity and snowball sampling strategies. In each of village, all houses, starting from one end of the village, were approached one after another to find participant children in the target age group (3–12 years). All eligible children present during visits were recruited, after obtaining informed consent from at least one parent. However, in several cases, a second visit was made to a household at a date fixed during the first visit. In this way, a whole village was covered, then the next village was approached.

As is normal in governmental facilities in the region, children start attending care centres for a mid-day meal and preliminary pre-nursery type education at age 3. As the study was aimed at pre-adolescent children, an upper age of 12 years was set – the average age of menarche of Bengalee girls (Bhadra *et al*., 2013). A total of 621 children (308 boys and 313 girls) aged 3–12 years were included from just over 600 households. A child's age was ascertained from their birth certificate or polio vaccination card. All participants belonged to families of Bengalee-speaking Hindu caste groups. Children who were reported by their parents as having any illness and/or physical deformity were not included in the study. The response rate was slightly over 90%. A pre-structured questionnaire was used to acquire socioeconomic and demographic information. Both parents' education levels were recorded as the highest standard they passed in school, college or university. Their occupations were also recorded. Total monthly income of the family was recorded in Indian currency. It was also enquired whether a family owned or rented their house. Number of living rooms in the household and total number of family members were also recorded. Three types of toilet facilities/practices (toilet type) were found among village residents: i) typical Indian type with concrete structures, ii) temporary pit type (abandoned when filled up with night soil and a new one dug) and iii) no latrine in household and thus, open air defecation in the riverside fields. For the purpose of analysis, the first type was recorded as a 'proper' type and the second and the third types were clubbed together as 'improper' types. Cooking fuel was recorded as being either smoke-generating or not. Parents of children were asked if their child had any illness and whether they had experienced any kind of illness in the previous month (child morbidity status). All this information was obtained by interviewing parents.

Anthropometry and nutritional status

One of the researchers (PK) performed the anthropometric measurements. Weight (kg) and height (cm) were measured for each child to the nearest 1 mm and 500 g, respectively, following standard procedures (Lohman *et al*., 1988). Technical Errors of Measurements (TEM) were computed after Ulijaszek and Kerr (1999) and were found to be well within the reference range of values, and were thus not incorporated in the analyses. Nutritional status was assessed using growth reference value of the National Centers for Health Statistics (NCHS), US. Three types of *z*-scores were calculated – height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) – to determine stunting, underweight and wasting, respectively. Age- and sex-specific <-2SD *z*-scores were considered the cut-off points for underweight, stunting and wasting. The same data were used to calculate the variable CIAF (Nandy *et al*., 2005) by classifying children into seven categories (see Table 1). The reason for using NCHS standards was the age range of participants (3–12 years). The construction of CIAF requires HAZ, WAZ and WHZ – all three *z*-score values. However, other acceptable growth standards, such as the latest WHO standard (WHO, 2006), do not provide reference values of WAZ for age 10–12 years or WHZ for age above 5 years. Moreover, the NCHS cut-offs were used as most of the previously reported studies on CIAF worldwide have used these values. Thus, the appropriateness of comparison of the different components of CIAF of the present study with these earlier investigations was possible using NCHS *z*-scores.

Data analyses

Percentage statistics were used to describe the frequencies of participants in each sex and different nutritional categories (stunting, wasting, CIAF etc.). Chi-squared analysis (χ^2) was employed to assess the significance of differences in prevalence of CIAF between the sexes as well as the association between nutritional indicators and socioeconomic parameters in boys and girls. The variables showing a significant association in the χ^2 tests were further used as independent variables in multiple binary logistic regression (MBLR) analyses to assess their relative impacts on CIAF status (yes/no). Odds ratios (ORs), along with 95% confidence intervals (CIs), were used to assess the risks of AF. The MBLR was performed in two different ways. First, all predictors were put together (method: *Enter*) at once and the mutual effects were noted. Finally, in the second approach, the *forward step wise* method was used to identify the most important predictor(s) of AF.

For all these analyses, the outcome/dependent variable (CIAF) was categorized into '0' (indicating 'No AF') and '1' (indicating 'AF'). Parental education was classified into two categories: up to upper primary level and above upper primary level (because a very few parents had education above secondary school level). Other predictor variables included: house ownership (owned vs rented), number of living rooms (1, 2–4 and ≥ 5), toilet type (proper Indian type toilet vs pit type and/or open air defecation) and type of the cooking fuel used (smokeless vs smoky). For each of these predictors, the superior alternatives (such as, smokeless fuel) were coded '0' and the respective poorer options (such as, smoky fuel) was coded '1'. A *p*-value of <0.05 was considered to be statistically significant. All statistical analyses were performed through SPSS-16 software for Windows.

Results

Table 2 shows the prevalence of undernutrition among the study children. The overall prevalence of CIAF was 59.40% and this was higher than the three conventional indices of stunting (28.34%), wasting (30.76%) and underweight (44.61%). Boys had significantly higher prevalence of

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Table 1. Classification of Composite Index of anthropometric failure (CIAF)[a] among children

Group	Description	Wasting	Stunting	Underweight
A	No failure	No	No	No
B	Wasting only	Yes	No	No
C	Wasting & Underweight	Yes	No	Yes
D	Wasting, Stunting & Underweight	Yes	Yes	Yes
E	Stunting & Underweight	No	Yes	Yes
F	Stunting only	No	Yes	No
Y	Underweight only	No	No	Yes

A=no anthropometric failure; B, C, D, E, F and Y=anthropometric failure.
[a]Following Nandy *et al.* (2005).

underweight ($\chi^2 = 4.14$, $p<0.01$) compared to girls. The sex differences in prevalence of other indicators of undernourishment, however, were not statistically significant.

The prevalences of anthropometric failure as measured by CIAF by socioeconomic characteristics are shown in Table 3, along with the results of the χ^2 analyses to assess the significance of those differences. Significant associations with the prevalence of CIAF were observed for father's education ($\chi^2 = 6.22$, $p<0.01$), mother's education ($\chi^2 = 11.84$, $p<0.001$), house ownership status ($\chi^2 = 8.36$, $p<0.01$), number of living rooms ($\chi^2 = 5.71$, $p<0.05$), toilet type ($\chi^2 = 3.76$, $p<0.05$) and fuel type ($\chi^2 = 4.94$, $p<0.05$). Lower parental education level, rented house (although the sample size was small), fewer living rooms in the house, poor quality of toilet type (pit or open) and use of smoky fuel were all associated with a significantly higher prevalence of CIAF (Table 3). It is worth mentioning that parental occupation and family income and expenditure were not significantly associated with nutritional status.

Multiple logistic regression analysis was performed on those predictor variables that showed significant associations with CIAF in the χ^2 analyses to assess their relative or mutually exclusive effects on CIAF status, independent of each other. Only maternal educational status showed a significant effect amongst all the other predictors (Wald's $\chi^2 = 5.381$; $p<0.05$). A lower maternal educational level (up to upper primary) was associated with a greater risk of AF (OR = 1.63; 95% CI = 1.07–2.47) compared with a higher maternal education level. Finally, forward stepwise logistic regression analysis excluded all other variables from the equation and retained only mother's education as the only significant predictor (Wald's $\chi^2 = 11.67$, $p<0.01$). Maternal educational level up to upper primary gave a greater risk (OR = 1.872; 95% CI = 1.31–2.68) of having a child with CIAF (results not shown in a tabular form).

Discussion

The study results show that the conventional indicators of undernourishment underestimate the prevalence of undernutrition compared with CIAF. While the classical indicators showed the prevalence to be roughly between 28 and 45%, the prevalence of CIAF was calculated to be 59.4%, with boys tending to have a higher prevalence of undernourishment. As CIAF includes the prevalence of stunting, wasting and underweight together to produce an overall estimate of the undernourished state ('anthropometric failure', AF), the prevalence is usually higher than that estimated by any one of the conventional indicators. A similar prevalence of CIAF has previously been observed in rural children (50.20%) of the same district, Purba Medinipur (Acharya *et al.*, 2013). A few previous studies have also reported a higher prevalence of CIAF among children of different states of India, including Tamil Nadu (86.6%, Seetharaman *et al.*, 2007),

Table 2. Prevalence of undernutrition among rural children aged 3–12 years, West Bengal, India

	N (%)	Underweight	Not Underweight	Stunted	Not Stunted	Wasted	Not wasted	AF	No AF
Boys	308 (49.60)	150 (48.70)	158 (51.30)	88 (28.60)	220 (71.40)	99 (32.10)	209 (67.90)	185 (60.06)	123 (39.94)
Girls	313 (50.40)	127 (40.60)	186 (59.40)	88 (28.10)	225 (71.90)	92 (29.40)	221 (70.60)	184 (58.79)	129 (41.21)
χ^2	0.40	4.14*		0.02		0.55		0.11	
Boys and girls combined	621 (100)	277 (44.61)	344 (55.39)	176 (28.34)	445 (71.66)	191 (30.76)	430 (69.24)	369 (59.40)	252 (40.60)

*$p<0.05$.

Table 3. Association of socio-demographic characteristics and reported illness with anthropometric failure as assessed by CIAF among the rural children aged 3–12 years, West Bengal, India

Variable	Category	No AF		AF		
		n	%	*n*	%	χ^2
Father's education	Up to upper primary	172	37.64	285	62.36	6.22**
	Above upper primary	80	48.78	84	51.22	
Mother's education	Up to upper primary	166	36.48	289	63.52	11.84***
	Above upper primary	86	51.81	80	48.19	
Mother's occupation	Housewife	214	41.15	306	58.85	0.47
	Manual	9	39.13	14	60.87	
	Non-manual	29	37.18	49	62.82	
Father's occupation	Manual	175	40.23	260	59.77	0.07
	Non-manual	77	41.40	109	58.60	
Family income (*per capita*)	≤1400 Rs	85	40.48	125	59.52	0.43
	1401–8332 Rs	165	40.84	239	59.16	
	≥8333 Rs	2	28.57	5	71.43	
Family expenditure (*per capita*)	≤1249 Rs	95	40.77	138	59.23	0.13
	1250–6873 Rs	155	40.58	227	59.42	
	≥6874 Rs	2	33.33	4	66.67	
House ownership	Owned	252	41.38	357	58.62	8.36**
	Rented	0	0.00	12	100.00	
Number of living rooms	1 room	108	36.24	190	63.76	5.71*
	2–4 rooms	140	44.16	177	55.84	
	≥5 rooms	4	66.67	2	33.33	
Number of family members	1–4 members	96	39.83	145	60.17	1.85
	5–6 members	117	43.17	154	56.83	
	>7 members	39	35.78	70	64.22	
Toilet type	Pit/open	74	35.24	136	64.76	3.76*
	Indian type	178	43.31	233	56.69	
Fuel types	(Smokeless)	16	61.54	10	38.46	4.94*
	(Smoke)	236	39.66	359	60.34	
Reported illness	(within 2 months)	76	37.07	129	62.93	6.99*
	(within 3-5 months)	81	36.99	138	63.01	
	(within 6 months)	95	48.22	102	51.78	

*$p<0.05$; **$p<0.01$; ***$p<0.001$.

Uttar Pradesh (62.8%, Kumar *et al.*, 2010) and Jammu and Kashmir (73.2%, Dewan *et al.*, 2015). Studies have also reported different prevalences of CIAF among preschool children from other places within West Bengal state, including Nadia (60.4%, Biswas *et al.*, 2009), Midnapore Town (58.2%, Sinha & Maiti, 2012), Singur (32.7%, Dasgupta *et al.*, 2015), South 24 Parganas (61.28%, Biswas *et al.*, 2018) and Purba Medinipur (55.3%, Khanra *et al.*, 2019).

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Despite the enormous economic progress achieved in the past two to three decades, undernourishment among children in both urban and rural India has claimed many lives due to the immense population size, illiteracy, inadequate access to health facilities and socioeconomic disparities (Pal *et al*., 2017). The present study has shown that the nutritional status (measured by CIAF) of children in West Bengal was significantly associated with fathers' education, mother's education, house ownership status, number of living rooms, toilet type and cooking fuel type. A higher prevalence of CIAF was associated with lower parental education level, living in a rental house (in contrast to an owned house), having fewer living rooms, having a poor quality toilet (pit or open) and the use of smoky cooking fuel. Lower or poorer levels or qualities of these factors were associated with a higher risk of CIAF than higher levels or better qualities. For instance, CIAF was significantly higher in children whose parents were educated up to upper primary or less, compared with children whose parents were educated above upper primary level. However, in the multivariate analysis, only mother's education level showed significant inverse relationship with prevalence of undernutrition (AF). Higher maternal education was associated with a lower prevalence of AF. Parental occupation and family income and expenditure were not significantly associated with the nutritional status of children.

Hitherto, different studies have shown that various indicators of socioeconomic status, such as educational level of parents, parental income and family assets, are associated with children's nutritional status (Victora *et al*., 2008; Nguyen *et al*., 2013; Keino *et al*., 2014; Mohammad *et al*., 2014). It has been suggested by many scholars that improvement in socioeconomic conditions, along with parental education and the prevention of infection through personal hygiene, might help to improve the nutritional status of children (Meshram *et al*., 2012; Kavosi *et al*., 2014; Owoaje *et al*., 2014; Garcia Cruz *et al*., 2017; Pal *et al*., 2017; Vollmer *et al*., 2017; Roy *et al*., 2018). Poor sanitary systems have also been closely linked to diarrhoeal disease, environmental enteropathy and worm infection (Walker *et al*., 2013). The present study found a lower prevalence of undernutrition among children belonging to families using smokeless cooking fuel. Previous studies have also showed that use of unclean, smoky cooking fuel has long-lasting effects on the growth, health and nutritional status of children (Mishra & Retherford, 2007; Bhagowalia & Gupta, 2011).

Mother's education is very often considered to be the most significant predictor of child undernutrition (Stamenkovic *et al*., 2016). Although low household income is most likely to produce undernourishment in children, education is believed to act as a protective factor, with children whose mothers have a higher level of education being likely to be better nourished (Nguyen *et al*., 2013; Keino *et al*., 2014; Mohammad *et al*., 2014). Among the children of the present study, mother's education level was the single most significant factor associated with CIAF, adjusting for the effects of all other factors. The prevalence of CIAF was significantly higher in children whose mothers were educated only up to upper primary level compared with those educated above upper primary level. A study in Ethiopia showed that children over 12 months of age born to uneducated mothers and with poor wealth status had higher odds of being malnourished as assessed by CIAF (Endris *et al*., 2017). Kamiya (2011) showed that, in Laos, level of parental education, household assets, hygiene standards and water quality were the most important determinants of nutritional status in children. A recent study revealed that growth in Indonesian school children was directly associated with parental education and that this influence was not via nutrition-mediated pathways (Groth *et al*., 2019). Another study in Laos found that low maternal education, poor nutrition knowledge and restricted intake of meats were interlinked and considered to be the main contributors to childhood malnutrition (Phengxay *et al*., 2007). Children of educated mothers experience lower mortality as well as lower prevalence of undernourishment than children of uneducated mothers (Gwatkin *et al*., 2000).

Maternal education can exert a crucial effect on the nutritional and health status of children through several mediating mechanisms. It can lead women to greater exposure to, and better understanding of, guidelines and recommendations for better health through mass media and other literary sources. Educated mothers indeed show better knowledge and practice of feeding

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and health management for their children (Frost *et al.*, 2005; Makoka & Masibo, 2015; Smith *et al.*, 2016). Additionally, they are better able to read medical instructions for the treatment of childhood illness and apply the treatment, and increased number of years in school makes women more receptive to modern medicine (Glewwe, 1999). Higher educated mothers have been found to have a better understanding of the causes, means of prevention, recognition and cures for disease, as well as nutritional requirements, than lesser educated women (Kraamwinkel *et al.*, 2019). Several previous studies have clearly indicated that mother's education is vital for good child health and nutrition (Owoaje *et al.*, 2014; Makoka & Masibo, 2015; Garcia Cruz *et al.*, 2017; Vollmer *et al.*, 2017; Roy *et al.*, 2018; Kraamwinkel *et al.*, 2019). Studies have also revealed a strong link between maternal education, socioeconomic status and child nutrition. This is because educated women are more likely to get steady and better paid jobs, or marry men with higher education and higher income, and as a result have a modest living standard, which ultimately have positive effects on child health and survival (Cleland & Van Ginneken, 1988; Desai & Alva, 1998). It has often been found in low-resource settings that women are more likely than men to mobilize resources towards the well-being of their children (UNICEF, 2011), and that women with higher decision-making power have fewer undernourished children than women with lesser power (Cumnnigham *et al.,* 2015). A higher level of education could make women more capable of exercising decision-making power at the household level (Cheng, 2019). Therefore, although mother's education does not influence a child's growth directly, it does so indirectly via other factors that exert an influence on child nutritional status. The tangible improvement of women's education should be a major goal towards the attainment of sustainable development of child health and development at the community level in India.

In conclusion, this study found that, although the participating rural Bengalee children were beneficiaries of two national nutritional supplementation programmes (MDM and ICDS), they had a very high prevalence of undernutrition (CIAF = 59.4 %). It further showed that, even in a population where women's educational levels were lower than average, a little variation in this could significantly affect child nutritional condition at the community level. A lower level of maternal education was found to be significantly associated with a higher prevalence of anthropometric failure, as measured by CIAF, and this effect was independent of several other parameters of socioeconomic status. The study also indicated that the health and nutritional status of children is sensitive to mother's education level, even in a low-resource setting where the education level of mothers is also low, in general, and the range of variation in education level was also minimal.

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Conflicts of Interest. The authors of this paper do not have any conflicts of interest.

Ethical Approval. Necessary approval was obtained from the appropriate administrative offices (BDO, CDPO and Gram Panchayat) before commencement of the study. The relevant institutional committee of Vidyasagar University Midnapore assessed the ethical standards of the research proposal and approved the study. The ethical guidelines as laid down in the World Medical Association Declaration of Helsinki, 1975, as revised in 2008, were strictly followed.

References

Abbasi S, Mahmood H, Zaman A, Farooq B, Malik A and Saga Z (2018) Indicators of malnutrition in under 5 Pakistani children: a DHS data secondary analysis. *Journal of Medical Research and Health Education* **2**(3), 1–10.

Abuya BA, Ciera J and Kimani-Murage E (2012) Effect of mother's education on child's nutritional status in the slums of Nairobi. *BMC Pediatrics* **12**(80), 1–10.

Acharya A, Mandal GC and Bose K (2013) Overall burden of under-nutrition measured by a composite index in rural preschool children in Purba Medinipur, West Bengal, India. *Anthropological Review* **76**(1), 109–116.

https://doi.org/10.1017/S0021932020000577 Published online by Cambridge University Press

Ahmadi D, Amarnani E, Sen A, Ebadi N, Cortbaoui P and Melgar-Quiñonez H (2018) Determinants of child anthropometric indicators in Ethiopia. *BMC Public Health* **18**(1), 626.
Akresh R, Lucchetti L and Thirumurthy H (2012) Wars and child health: evidence from the Eritrean–Ethiopian conflict. *Journal of Development Economics* **99**(2), 330–340.
Arora D, Datta S and Sau S K (2014) An assessment of socio-economic factors on nutritional status in primary school – a cross sectional study in Purulia of West Bengal. *International Journal of Occupational Safety and Health* **4**(2), 15–18.
Bhadra M, Mukhopadhyay A, Chakraborty R, Bose K, Koziel S and Ulijaszek S (2013) Relative fat distribution in relation to menarcheal status among Bengalee Hindu girls of West Bengal, India. *Journal of Natural Sciences Biology and Medicine* **4**, 369–373.
Bhagowalia P and Gupta P (2011) Nutritional status and access to clean fuels: evidence from South Asia. Paper presented at the *Agricultural and Applied Economics Association's 2011 AAEA and NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania*, pp. 1–24
Biswas S, Bose K and Koziel S (2011) Effect of some social factors on nutritional status among rural Bengalee preschool children from Eastern India. *Journal of Human Sciences* **8**(1), 289–300.
Biswas S, Bose K, Mukhopadhyay A and Bhadra M (2009) Prevalence of under nutrition among pre-school going children of Chapra, Nadia District, West Bengal, India, measured by composite index of anthropometric failure (CIAF). *Anthropologischer Anzeiger* **67**(3), 269–279.
Biswas S, Giri SP and Bose K (2018) 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. *Anthropological Review* **81**(3), 269–277.
Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M *et al.* (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *The Lancet* **382**(9890), 427–451.
Caldwell JC (1993). Health transition: the cultural, social and behavioural determinants of health in the Third World. *Social Science & Medicine* **36**(2), 125–135.
Chellamma P, Chandrasekharan Nair J, Suresh Lakshmi S, Jaleel S, Soman Chellappan S, Shameena S *et al.* (2017) Factors affecting the nutritional status of 3-6-year-old children attending Anganwadis in an urban area in Kerala. *Journal of Evolution of Medical and Dental Sciences* **6**(56), 4188–4192.
Cheng C (2019) Women's education, intergenerational coresidence, and household decision-making in China. *Journal of Marriage and Family* **81**, 115–132.
Cleland JG and Van Ginneken JK (1988). Maternal education and child survival in developing countries: the search for pathways of influence. *Social Science & Medicine* **27**(12), 1357–1368.
CSDH (2008) *Closing the Gap in a Generation: Health Equity Through Action on The Social Determinants of Health.* Final Report of the Commission on the Social Determinants of Healt. Commission on the Social Determinants of Health, Geneva, p. 247.
Cunningham K, Ruel M, Ferguson E and Uauy R (2015) Women's empowerment and child nutritional status in South Asia: a synthesis of the literature. *Maternal and Child Nutrition* **11**, 1–19.
Dasgupta A, Sahoo SK, Taraphdar P, Preeti P S, Biswas D, Kumar A and Sarkar I (2015) Composite index of anthropometric failure and its important correlates: a study among under-5 children in slum of Kolkata, West Bengal, India. *International Journal of Medical Science and Public Health* **4**(3), 414–419.
Dearden KA, Schott W, Crookston BT, Humphries DL, Penny ME and Behrman JR (2017) Children with access to improved sanitation but not improved water are at lower risk of stunting compared to children without access: a cohort study in Ethiopia, India, Peru, and Vietnam. *BMC Public Health* **17**(1), 110.
Desai S and Alva S (1998) Maternal education and child health: is there a strong causal relationship? *Demography* **35**(1), 71.
Dewan D, Gupta R, and Kumar D (2015) Can we rely solely on conventional measures to estimate under nutrition among under fives? *Indian Journal of Community Health* **27**(3), 361–365.
Elema T (2018) Predictors for the prevalence of under-nutrition, wasting and stunting of 3 to 12 years school aged children in the Asella Luther Child Development Project – Oromiyaa, Ethiopia. *Journal of Nutrition and Human Health* **2**(2), 1–10.
Emina J, Kandala N, Inungu J and Yazoume Y (2011) Maternal education and child nutritional status in the Democratic Republic of Congo. *Journal of Public Health and Epidemiology* **3**(12), 576–592.
Endris N, Asefa H and Dube L (2017) Prevalence of malnutrition and associated factors among children in rural Ethiopia. *BioMed Research International*, Article ID 6587853, doi: https://doi.org/10.1155/2017/6587853
Fenn B, Bulti AT, Nduna T, Duffield A and Watson F (2012) An evaluation of an operations research project to reduce childhood stunting in a food-insecure area in Ethiopia. *Public Health Nutrition* **15**(9), 1746–1754.
Frost MB, Forste R and Haas DW (2005) Maternal education and child nutritional status in Bolivia: finding the links. *Social Science & Medicine* **60**(2), 395–407.
Garcia Cruz L, González Azpeitia G, Reyes Súarez D, Santana Rodríguez A, Loro Ferrer J and Serra-Majem L (2017) Factors associated with stunting among children aged 0 to 59 months from the Central region of Mozambique. *Nutrients* **9**(491), 1–16.
Giri SP, Biswas S and Bose K (2017) Prevalence of undernutrition among Bengalee preschool children of Sundarban, South 24 Parganas, West Bengal, India. *Human Biology Review* **6**(4), 284–300.

Glewwe P (1999) Why does mother's schooling raise child health in developing countries? *Evidence from Morocco. Journal of Human Resources* **34**(1), 124–159.

Groth D, Scheffler C and Hermanussen M (2019) Body height in stunted Indonesian children depends directly on parental education and not via a nutrition mediated pathway – evidence from tracing association chains by St. Nicolas House Analysis. *Anthropologischer Anzeiger* **76**(5), 445–451.

Gwatkin DR, Rustein S, Johnson S, Pande K and Wagstaff A (2000) *Socio-economic Differences in Health, Nutrition, and Population in Cameroon*. World Bank, Washington, DC.

Handa S (1999) Maternal education and child height. *Economic Development and Cultural Change* **47**(2), 421–439.

IFPRI (2016) *Global Nutrition Report 2016: From Promise to Impact: Ending Malnutrition by 2030*. International Food Policy Research Institute. IFPRI Publications, Washington, DC.

IIPS (2017) *National Family Health Survey (NFHS) 2015–2016*. International Institute for Population Sciences, Mumbai.

Kamiya Y (2011) Socioeconomic determinants of nutritional status of children in Lao PDR: effects of household and community factors. *Journal of Health, Population and Nutrition* **29**(4), 339–348.

Kavosi E, Hassanzadeh Rostami Z, Nasihatkon A, Moghadami M and Heidari M (2014) Prevalence and determinants of under-nutrition among children under six: a cross-sectional survey in Fars Province, Iran. *International Journal of Health Policy and Management* **3**(2), 71–76.

Keino S, Plasqui G, Ettyang G and van den Borne B (2014) Determinants of stunting and overweight among young children and adolescents in sub-Saharan Africa. *Food and Nutrition Bulletin* **35**(2), 167–178.

Khanra P, Biswas S and Bose K (2019) Nutritional assessment by composite index of anthropometric failure among school going children of Purba Medinipur, West Bengal, India. *Human Biology Review* **8**(1), 66–75.

Kraamwinkel N, Ekbrand H, Davia S and DaoudI A (2019) The influence of maternal agency on severe child undernutrition in conflict-ridden Nigeria: Modeling heterogeneous treatment effects with machine learning. *PLoS One* **14**(1), 1–16.

Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z *et al.* (2002) 2000 CDC growth charts for the United States: methods and development. *Vital and Health Statistics. Series 11: Data from the National Health Survey* **11**(246), 1–190.

Kumar D, Mittal PC and Sharma MK (2010) Socio-demographic risk factors of child undernutrition. *Journal of Pediatric Science* **2**, 1–11.

Lohman TG, Roche AF and Martorell R (1988) *Anthropometric Standardization Reference Manual*. Human Kinetics Books, Chicago, IL.

Makoka D and Masibo PK (2015) Is there a threshold level of maternal education sufficient to reduce child undernutrition? *Evidence from Malawi, Tanzania and Zimbabwe. BMC Pediatrics* **15** (96), 1–10

Mandal S, Prabhakar VP, Pal J, Parthasarathi R and Biswas R (2014) An assessment of nutritional status of children aged 0–14 years in a slum area of Kolkata. *International Journal of Medicine and Public Health* **4**(2), 159–162.

Mansur DI, Haque MK, Sharma K, Mehta DK and Shakya R (2015) A study on nutritional status of rural school going children in Kavre District. *Kathmandu University Medical Journal* **13**(2), 146–151.

Meshram II, Arlappa N, Balakrishna N, Laxmaiah A, Mallikarjun Rao K *et al.* (2012) Prevalence and determinants of undernutrition and its trends among pre-school tribal children of Maharashtra State, India. *Journal of Tropical Pediatrics* **58**(2), 125–132.

Mishra V and Retherford R. (2007) Does biofuel smoke contribute to anaemia and stunting in early childhood? *International Journal of Epidemiology* **36**(1), 117–119.

Mohammad K, Kassab M, Gamble J, Creedy DK and Foster J (2014) Factors associated with birth weight inequalities in Jordan. *International Nursing Review* **61**(3), 435–440.

Nandy S, Irving M, Gordon D, Subramanian SV and Smith GD (2005) Poverty, child undernutrition and morbidity: new evidence from India. *Bulletin of the World Health Organization* **83**(3), 210–216.

Nguyen, HT, Eriksson B, Petzold M, Bondjers G, Tran TK, Nguyen LT and Ascher H (2013) Factors associated with physical growth of children during the first two years of life in rural and urban areas of Vietnam. *BMC Pediatrics* **13**(149), 1–10

Owoaje E, Onifade O and Desmennu A (2014) Family and socioeconomic risk factors for undernutrition among children aged 6 to 23 months in Ibadan, Nigeria. *Pan African Medical Journal* **17**(161), 1–7.

Pal A, Pari AK, Sinha A and Dhara PC (2017) Prevalence of undernutrition and associated factors: a cross-sectional study among rural adolescents in West Bengal, India. *International Journal of Pediatrics and Adolescent Medicine* **4**(1), 9–18.

Phengxay M, Ali M, Yagyu F, Soulivanh P, Kuroiwa C and Ushijima H (2007) Risk factors for protein–energy malnutrition in children under 5 years: study from Luangprabang province, Laos. *Pediatrics International* **49**(2), 260–265.

Pramanik P, Bose Banerjee S and Dey S (2015) Prevalence of under nutrition and poor health status among primary school children in Burdwan West Bengal. *Scholars Journal of Applied Medical Sciences* **3**(5A), 1851–1857.

Ramesh S, Sundari S and Ramesh J (2017) Assessment of nutritional status by Composite Index of Anthropometric Failure (CIAF): a study among under-5 children in Chennai, Tamil Nadu, India. *Research Journal of Pharmaceutical, Biological and Chemical Sciences* **8**(3), 1495–1499.

Ray I and Chandra A (2013) An anthropometric study on the children of Tripura: nutritional and health coverage and redefining WHO percentile cut-off points. *International Journal of Scientific and Research Publications* **3**(5), 1–8.

Rengma MS, Bose K and Mondal N (2016) Socio-economic and demographic correlates of stunting among adolescents of Assam, North-east India. *Anthropological Review* **79**(4), 409–425.
Roy K, Dasgupta A, Roychoudhury N, Bandyopadhyay L, Mandal S and Paul B (2018) Assessment of under nutrition with composite index of anthropometric failure (CIAF) among under-five children in a rural area of West Bengal, India. *International Journal of Contemporary Pediatrics* **5**(4), 1651–1656.
Sarkar S (2016) Cross-sectional study of child malnutrition and associated risk factors among children aged under five in West Bengal, India. *International Journal of Population Studies* **2**(1), 89–102.
Sen J, Dey S and Mondal N (2011) Conventional nutritional indices and Composite Index of Anthropometric Failure: which seems more appropriate for assessing under-nutrition among children? *A cross-sectional study among school children of the Bengalee Muslim Population of North Bengal, India. Italian Journal of Public Health* **8**(2), 172–185.
Seetharaman N, Chacko TV, Shankar S and Mathew AC (2007) Measuring malnutrition – the role of *Z* scores and the composite index of anthropometric failure (CIAF). *Indian Journal of Community Medicine* **32**(1), 35–39.
Shafiq A, Hussain A, Asif M, Hwang J, Jameel A and Kanwel S (2019) The effect of "women's empowerment" on child nutritional status in Pakistan. *International Journal of Environmental Research and Public Health* **16**, 4499.
Sinha NK and Maiti S (2014) Prevalence of undernutrition among under-privileged pre-school children (2–6 yrs) of Midnapore town, India. *Malaysian Journal of Paediatrics and Child Health* **18**, 58–69.
Smith HA, Hourihane JOB, Kenny LC, Kiely M, Leahy-Warren P and Murray DM (2016) Infant Formula feeding practices in a prospective population based study. *BMC Pediatrics* **16**(205), 1–7
Smith KR (2000) National burden of disease in India from indoor air pollution. *Proceedings of the National Academy of Sciences of the USA* **97**(24), 13286–13293.
Stamenkovic Z, Djikanovic B, Laaser U and Bjegovic-Mikanovic V (2016) The role of mother's education in the nutritional status of children in Serbia. *Public Health Nutrition* **19**(15), 2734–2742.
Sunil T (2009) Effects of socio-economic and behavioural factors on childhood malnutrition in Yemen. *Maternal and Child Nutrition* **5**, 251–259.
Svedberg P (2000) *Poverty and Undernutrition. Theory, Measurement, and Policy : A Study Prepared for the World Institute for Development Economics Research of the United Nations University (UNU/WIDER)*. Oxford University Press, Oxford.
Teshome B, Kogi-Makau W, Getahun Z and Taye G (2009) Magnitude and determinants of stunting in children under five years of age in food surplus region of Ethiopia: the case of West Gojam Zone. *Ethiopian Journal of Health Development* **23**(2), 98–106
Ulijaszek S J and Kerr DA (1999) Anthropometric measurement error and the assessment of nutritional status. *British Journal of Nutrition* **82**(3), 165–177.
UNICEF (2011) *Gender Influences on Child Survival, Health and Nutrition: A Narrative Review*. United Nations Children's Fund, Geneva.
UNICEF (2019) *UNICEF–WHO–The World Bank: Joint Child Malnutrition Estimates – Levels and Trends – 2019 Edition.* UNICEF Data. URL: https://data.unicef.org/resources/jme/ (accessed 1st July 2019).
Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L and Sachdev HS (2008) Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet* **371**(9609), 340–357.
Vikram K and Vanneman R (2019) Maternal education and the multidimensionality of child health outcomes in India. *Journal of Biosocial Science* **51**(1), 1–21.
Vollmer S, Harttgen K, Kupka R and Subramanian SV (2017) Levels and trends of childhood undernutrition by wealth and education according to a Composite Index of Anthropometric Failure: evidence from 146 Demographic and Health Surveys from 39 countries. *BMJ Global Health* **2**(2), e000206.
Walker CLF, Rudan I, Liu L, Nair H, Theodoratou E, Bhutta ZA *et al.* (2013) Global burden of childhood pneumonia and diarrhoea. *The Lancet* **381**(9875), 1405–1416.
WHO (2006) *Child Growth Standards. Length/Height for age, Weight for Age, Weight for Length, Weight for Height and Body Mass Index for Age. Methods and Development.* World Health Organization, Geneva.
WHO (2010) *Nutrition Landscape Information System (NLIS) Country Profile Indicators: Interpretation Guide*. World Health Organization, Geneva.
Yadav AK, Kotwal A, Vaidya R and Yadav J (2016) Anthropometric indices and its socio-demographic determinants among primary school children of an urban school in Pune, India. *International Journal of Medicine and Public Health* **6**(4), 160–164.

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