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Original Research Article

Childhood undernutrition and its determinants: a cross-sectional study among under-five children in a slum of Kolkata, West Bengal, India

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ABSTRACT

Background: Undernutrition is an important risk for premature deaths and almost 45% of deaths in the under-five population are linked to undernutrition globally, where low- and middle-income countries (LMIC) bear a major share of it. This study aimed to measure the burden of such undernutrition and its determinants among the under-five children in a slum of Kolkata.
Methods: A community-based cross-sectional study was conducted between Oct 2022-February 2023 among 164 children aged between 6-59 months. Participants were selected by probabilistic sampling method; Mothers were interviewed and anthropometry of the children were measured. Prevalence of undernutrition was assessed by the composite index of anthropometric failure (CIAF). Logistic regression analysis was done to find out the associates of undernutrition.
Results: Median age of the study participants was 26.5 months, 54.3% of the participants being boy children. Regarding feeding of the child, 26.2% given prelecteal feeding, 17.7% didn't receive colostrum, 33.5% had delayed initiation of breast feeding, only 57.9% child received exclusive breastfeeding. Of the participants, 11% child delivered by home delivery and 32.9% had low-birth-weights. According to CIAF 68.9% had undernutrition, while underweight, stunting, and wasting were reported as per conventional index 44.5%, 56.7%, and 16.5% respectively. In multivariable logistic analysis undernutrition have significant association with low birth weight and repeated episode of cough and running nose [aOR= 0.99(0.98-0.99). aOR=2.32(1.06-5.09)] respectively.
Conclusions: Considerable proportion of children (two out of three) had undernutrition with CIAF. Preventive measures should include improvement in antenatal care, child feeding counselling and social determinants of health.

Keywords: CIAF, Low-birth-weight, Undernutrition

INTRODUCTION

Childhood undernutrition is a persistent global health concern, particularly prevalent in resource-constrained settings like urban slums. In the under-five age group, undernutrition manifests primarily as stunting, wasting and underweight, representing inadequate linear growth and weight faltering. Stunting, characterized by low height-for-age, reflects chronic malnutrition, while wasting, indicated by low weight-for-height, signifies acute malnutrition and underweight, indicated by low weight-for-age, signifies acute on chronic malnutrition.

Globally, the burden of undernutrition among children under-five remains alarmingly high. According to recent estimates, approximately 149 million children under the age of five are stunted, while 50 million are wasted. According to the reports of World Health Organization (WHO), almost 45% of deaths in the under-five population are linked to undernutrition, and low-and middle-income countries (LMIC) bear a major share of this.[1] These figures highlight the magnitude of the issue and emphasize the urgent need for targeted interventions to address childhood undernutrition comprehensively.

Despite being significantly high numbers, these conventional indicators present only part of the fact when reported individually.[2,3] Whereas a new indicator Composite Index of Anthropometric Failure (CIAF) suggested by Svedberg, composed of seven components: no failure, wasting only, stunting only, underweight only, wasting; underweight, stunting; underweight and wasting; underweight; stunting.[3,4] Across the world estimates with CIAF revealed a higher burden of undernutrition when compared with the conventional indicators.[5-8] At the regional level also, a significant proportion of undernutrition had been reported.[9,10]

In India, where one-third of the world's stunted children reside, undernutrition poses a significant public health challenge.[11] Within India, urban slums present unique health disparities, characterized by overcrowding, poor sanitation, inadequate access to healthcare, and limited nutritional resources. Children living in these environments face heightened risks of undernutrition due to socioeconomic inequities and environmental factors.

West Bengal, home to one of India's largest metropolitan areas, Kolkata, is emblematic of the broader health challenges faced by urban slum dwellers. In one of the slum dwellers in Kolkata, where we conducted a study to estimate the burden and factors associated with undernutrition among under-five children.

Despite the growing recognition of childhood undernutrition as a multifaceted issue, there remains a paucity of community-based research elucidating its determinants, especially in the context of urban slums. Addressing this research gap is imperative for developing evidence-based interventions tailored to the unique needs of vulnerable populations.

METHODS

Study type and setting

This cross-sectional community-based study was conducted in a slum of Kolkata city, West Bengal, India from October 2022 to February 2023. The slum, located within 5km of the central part of the city, with approximately 3000 residents and 700 households according to local personnel, without any government records.

Study population

Our study included married women of reproductive age with at least one child aged 6-59 months. We preferred mothers as primary respondents who had lived in the study area for at least one year. We excluded seriously ill or bedridden mothers, households where no one was available for the survey despite repeated visits, and cases where informed consent was not given. If a mother has multiple children aged 6-59 months, we chose the youngest to minimize recall bias.

Sample size

In the Indian scenario, a nationwide estimate based on National Family Health Survey 2015-2016 (NFHS-4) data, revealed around 56% of the under-five children with some form of anthropometric failure as per CIAF.[12] So, $P = 0.56$, $(1-P) = (0.44)$, L (error) =0.10, $Z_{1-\alpha/2} = 1.96$*(at 95% CI).* So, from this ($Z_{1-\alpha/2}{}^2 * P * (1-P)/L^2$) formula final sample was 95. As the simple random sampling not performed, we added 1.5 design effect, where the sample size comes to 143 and finally adding 15% nonresponsiveness, final sample size reach to =168.2~ 169.

Sampling design

Multistage area sampling was performed. First, we transect the total area with local personnel, where we found that 18 lanes are connected internally within the whole area which divided the whole area into 29 small areas. Due to accessibility challenges, we randomly selected 17 of these areas and tried to collected 10 samples from each area.

Data collection

After Institutional Ethics Committee approval, we conducted house-to-house visits, listing children in 17 areas and randomly selecting 10 children from each area. Again, after listing followed by randomly selection, we visited each of the selected household in each area for interview. In some areas, 5 mothers or family members declined participation, resulting in a final sample size of 164. Face-to-face interviews were conducted with mothers or primary caregivers after obtaining written informed consent using a pre-designed, pre-tested, semi-structured schedule in Bengali.

Study variables

Outcome variable (nutritional status of the child): We assessed under-five children's nutritional status using CIAF, categorizing it as anthropometric failure (yes or no)

Independent variables: A series of information was taken from the respondent and mother and child protection (MCP) card during the interview.

Sociodemographic and socioeconomic details: Child's age (in months), gender, parents' age, age at marriage and first childbirth of the mother, parent's education and occupation, family type, per capita income, religion and caste.

Birth details: Recorded place and mode of delivery, with birth weight (<2500 grams considered low birth weight) retrieved from MCP card or recalled by the respondent if documentation was unavailable.

Feeding history: Interviewed mothers for prelecteal feeding, colostrum feeding, breastfeeding, and the current dietary history of child. Exclusively breastfeeding defined as no prelacteal feeding and exclusive breast milk feeding for the first six months.

Dietary diversity: Assessed using the infant and young child feeding (IYCF-2007) seven food group assessment tool, with minimal dietary diversity defined as consumption of four or more food groups in last 24 hours.

Illness: Any illness of the child within two weeks of the interview considered as acute illness while any persistent conditions for long period preferably more than 3 months considered as chronic illness.

Immunization status of the child: The child is considered fully immunized if all birth doses, three doses of OPV, DPT, Hep-b, and one dose of measles are taken within one year of age or age-appropriate vaccine coverage completed for children aged 6-11 months as per the national immunization schedule.

Measurement

Anthropometric measurements followed standard procedures. Data included weight (Measured to the nearest 0.1kg), recumbent length (if child cannot stand without support), and height (measured to the nearest 0.1cm). weight was measured using a Salter weighing machine and standard scale, while height was measured using a non-stretchable tape fixed to a vertical wall, with the participant standing on a firm surface.

Statistical analysis

Data was entered into Microsoft Excel. Z scores were calculated using WHO Anthro Survey analyser. Final analysis conducted using SPSS version 16, including descriptive and inferential statistics like univariate and multivariable logistic regression. Biologically plausible variables with a *P*-value <0.25 in univariate models were included in the final multivariable model. Missing data were excluded from analysis.

RESULTS

In the sample of 164 under-five children, the median age was 26.5 months, with 54.3% being boys. Majority (81.1%) of children were from middle to lower-middle economic class families according to modified BG Prasad scale 2021. About 33.5% of fathers and 21.3% of mothers had no formal education, while only 10.3% of fathers and 13.4% of mothers studied secondary education or higher. All fathers worked in the unorganized sector, with 26.8% working as drivers, 14.6% in a plastic factory, 11.6% in a chappal factory, 10.4% as daily wage workers, and 8.5% as rickshaw pullers. Additionally, 14% of mothers worked outside, primarily as maids (Table 1).

Table 1: Sociodemographic characteristics of the study participants and parents (n=164).

Variables	Category	Number (%)
Age of the child	6 to 23 months	72 (43.9)
	24 to 59 months	92 (56.1)
	Median (IQR): 26.5(14-41.75)	Range (6-59)
Sex of the child	Boy child	89 (54.3)
	Girl child	75 (45.7)
Socio economic class (according to modified B G Prasad scale 2021)	Upper	1 (0.6)
	Upper middle	18 (11.0)
	Middle	53 (32.3)
	Lower middle	80 (48.8)
	Lower	12 (7.3)
Type of family	Nuclear	100 (61.0)
	Joint	64 (39.0)
Education of mother	Non formal education	35 (21.3)
	Below primary	4 (2.4)
	Primary	77 (47)
	Middle	26 (15.9)
	Secondary and above	22 (13.4)
Education of father	Non formal education	55 (33.5)
	Below primary	9 (5.5)
	Primary	57 (34.8)
	Middle	26 (15.9)
	Secondary and above	17 (10.3)
Occupation of the father	Driver	43 (26.2)
	Work in a plastic factory	24 (14.6)
	Chappal factory	19 (11.6)
	Daily wager	17 (10.4)
	Rickshaw puller	14 (8.5)
	Rubber factory	10 (6.0)
	Others†	37 (22.6)

†Working in metal extraction factory, food delivery, mason, shop keeper, work in abroad, hand craft. Almost 95% of the residents were muslin in religion

Regarding feeding of the child, 26.2% of the baby were given prelecteal feeding, and 17.7% did not receive colostrum soon after birth. Breastfeeding initiation was

delayed for 33.5% of participants. Only 57.9% of children received exclusive breastfeeding, and 61% of mothers stopped breastfeeding before two years. Overall, 32.9% had low birth weights, and approximately 32% were delivered by caesarean section. Additionally, 11% of babies were delivered at home (Figure 1) (Table 2).

Table 2: Breast feeding details, dietary diversity, birth and maternal details of the study participants (n=164).

Variable	Category	Number (%)
Pre-lacteal feeding	No pre-lacteal feed given	121 (73.8)
	Pre-lacteal feed given	43 (26.2)
Colostrum feeding	Colostrum fed	135 (82.3)
	Not colostrum fed	29 (17.7)
Breast feeding initiation	Within 1 hr	109 (66.5)
	More than 1 hrs	55 (33.5)
Exclusive breast feeding	Exclusively breast fed	95 (57.9)
	Not exclusively breast fed	69 (42.1)
Continuation of feeding	Stopped after 24 months	64 (39)
	Stopped before 24 months	100 (61)
Minimum dietary diversity (MDD)	Present	114 (69.5)
	Absent	50 (30.1)
Place of delivery	Home delivery	18 (11.0)
	Government hospital	144 (87.8)
	Private hospital	2 (1.2)
Type of delivery	Normal delivery	111 (67.7)
	Caesarean section	52 (31.7)
Birth weight‡	Normal birth weight	107 (65.2)
	Low birth weight	54 (32.9)
	Median (IQR): 2600(2250-3010)	Range (1240-4000)
Mothers had three or more than three children	No	118 (72)
	Yes	46 (28)
Age of marriage before completed of 19 yrs	No	40 (24.4)
	Yes	124 (75.6)
Age of 1st child birth before completed of 20 yrs	No	52 (31.7)
	Yes	112 (68.3)
Two doses of tetanus toxoid	Not taken	12 (7.3)
	Taken	152 (92.7)
Rapid repeat childbirth (2 delivery within 3yrs)	Yes	63 (38.3)
	No	101 (61.7)
Unplanned pregnancy	Yes	88 (53.7)
	No	75 (46.3)
Abortion	Single	40 (24.4)
	Multiple	8 (4.8)
Pregnancy related complication (related to study participants)Œ	Absent	113 (69.8)
	Present	51 (31.1)

‡Birth weight of three home delivered children not measured (those three missing data were excluded while analysis)
ŒMajority of complication including 21 mothers had pregnancy induced hypertension, 5 mothers had eclampsia, 5 mothers had post-partum haemorrhage, 4 mothers had gestational diabetes mellites. Additionally, one mother died after home delivery.
ÞRelated to youngest 6-59m old child

The majority (75.6%) of the mothers were married before 19 years old. 68.3% of mothers give birth to their first child before 20yearsold, and 28% had three or more living children. Related to our study participants, most pregnancies (53.8%) were unplanned, and 38.3% lacked spacing between childbirths. Regarding antenatal care, 7.3% of mothers did not receive two doses of tetanus toxoid, and 31.1% experienced pregnancy-related complications, including 12.8% with pregnancy-induced hypertension. Around 30% of mothers had single or multiple abortions, spontaneous or induced (Table 2).

Using conventional indicators, 44.5% of children were underweight, with 12.8% severely underweight. Stunting affected 56.7%, with 26.2% severely stunted. Wasting was observed in 16.5%, including 4.9% severely wasted. Using CIAF, undernourishment was found in 68.9% of

children, with various combinations observed: no undernourishment (31.1%), underweight only (4.9%), stunting only (23.8%), wasting only (0.6%), underweight and stunting (23.8%), underweight and wasting (6.7%), and underweight, stunting and wasting (9.1%) (Table 3).

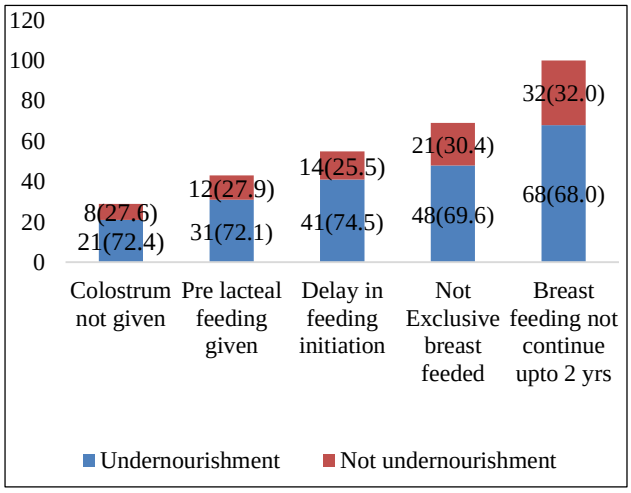

Figure 1: Poor feeding practices and nourishment status.

During the interview, 60.4% of respondents reported their children experiencing either acute or chronic health condition, with 45.5% had repeated episode of cough and running nose. Additionally, 34.8% of children were unimmunized according to their age (Table 3).

Factor associated: In the univariate logistic regression, low birthweight children had higher odds of anthropometric failure compared to normal birthweight children [4.51(1.86-10.91), p-<0.001], also in continuous scale of birth weight, lower odds of anthropometric failure seen in children [0.99(0.98-0.99), P<0.001]. Additionally, mothers' weight in continuous scale showed lower odds of anthropometric failure [0.96(0.94-0.99), P-0.04]. However, children with repeated episode of cough and running nose had higher odds of anthropometric failure, but it was significant at 90% CI [1.96(0.98-3.91, P-0.051].

In the multivariable logistic regression, lower birth weight remained a significant predictor of anthropometric failure [0.99(0.98-0.99), P<0.001], while the association with mothers' weight became insignificant. But, children with repeated episode of cough and running nose still had higher odds of anthropometric failure at 95% CI [2.32(1.06-5.09), P-0.03]. Others variables like age, gender, parental education and occupation, family income, feeding practices, immunization status, early marriage and teenage pregnancy of the mother, birth order, and pregnancy complications did not show significant associations with anthropometric failure in both univariate and multivariable analysis (Table 4).

Table 3: Underweight, stunting, wasting, Composite Index of Anthropometric Failure (CIAF) and various acute and chronic morbidities (n=164).

Variable	Category	Number (%)
Underweight	Not underweight*	91 (55.5)
	Moderate underweight #	52 (31.7)
	Severe underweight&	21 (12.8)
Stunting	No stunting*	71 (43.3)
	Moderate stunting#	50 (30.5)
	Severe stunting&	43 (26.2)
Wasting	No wasting*	137 (83.5)
	Moderate wasting&	19 (11.6)
	Severe wasting	8 (4.9)
Composite Index of Anthropometric Failure (CIAF)	No undernourishment	51 (31.1)
	Underweight only	8 (4.9)
	Stunting only	39 (23.8)
	Wasting only	1 (0.6)
	Underweight and stunting	39 (23.8)
	Underweight and wasting	11 (6.7)
	Underweight, stunting, and wasting	15 (9.1)
Health conditions (acute and chronic)£	Absent	65 (39.6)
	Present	99 (60.4)
Repeated episode of cough running nose	Absent	91 (55.5)
	Present	73 (44.5)
History of fever in last 14 days	Absent	115 (70.1)
	Present	49 (29.9)
History of breathlessness in last 14 days without any fever	Absent	158 (96.3)
	Present	6 (3.7)

Continued.

Variable	Category	Number (%)
History of diarrhoea in last 14 days	Absent	158 (96.3)
	Present	6 (3.7)
Others (chronic health condition)**	Absent	144 (87.8)
	Present	20 (12.2)

*(Z score for either weight for age/ height for age/height for weight ≥ -2sd)
(-3sd ≤ Z score for either weight for age/ height for age/height for weight <-2sd)
& (Z score for either weight for age/ height for age/height for weight < -3sd)
£ Multiple response included
**9 children had skin diseases, 7 children had chronic respiratory morbidity probably asthma, 4 children had congenital anomaly like; one had sold mass over chest, DDH, umbilical hernia, tongue tie

Table 4: Showing association between Composite index of anthropometric failure (CIAF) and various independent variables.

Variables	Category	Undernutrition (Ref= No undernutrition)				
		Number (%)	uOR(95%CI)	P value	aOR(95%CI)	P value
Mothers' education§	-	-	0.92(0.84-1.01)	0.11	0.96(0.86-1.07)	0.49
Education of father	-	-	0.93(0.85-1.01)	0.12	-	-
Education of father§	Middle school and above	28 (65.1)	0.52(0.21-1.27)	0.15	0.53(0.18-1.53)	0.24
	Class 1 to class 7	42 (63.6)	0.48(0.21-1.10)	0.08	0.43(0.17-1.11)	0.08
	Non formal edu.	43 (78.2)	1	-	1	-
Per capita income§ (in rupees)	-	-	1.0(1.0-1.0)	0.16	1.0(1.0-1.0)	0.56
Birth weight (in gm)	LBW	47 (87)	4.51(1.86-10.91)	0.001	-	-
	Normal	64 (59.8)	1	-	-	-
Birth weight§ (in gm)	-	-	0.99(0.98-0.99)	<0.001	0.99(0.98-0.99)	<0.001
Repeated episode of cough & running nose§	Present	56 (76.7)	1.96(0.98-3.91)	0.051	2.32(1.06-5.09)	0.03
	Absent	57 (65.6)	1		1	
Mothers BMI (kg/m^2)	-	-	0.94(0.87-1.09)	0.08	-	-
Mothers weight§ (in kg)	-	-	0.96(0.94-0.99)	0.04	0.98(0.95-1.06)	0.44
Mothers' height§ (in meter)	-	-	0.95(0.88-1.01)	0.12	0.98(0.90-1.06)	0.65

§[Those variables were placed in final model]
(Model adjusted for those variables had P- value <0.25 in univariate logistic regression, including mother education, education of father, per capita income, birth weight of the participants, cough and running nose of the participants, mothers' weight and mothers' height).
The model consisted with all those above variables provided best fitted model, where model statistics provided as, Cox and Snell R2 and Nagelkerke R2 value: 0.19 and 0.26, Hosmer Lemeshow test: Chi square- 8.06, P value- 0.337

DISCUSSION

Around two out of three children in our study are undernourished, a higher proportion than the reported in the National Family Health Survey-4 (NFHS-4), 2015-2016. As per conventional index even Stunting (56.7%) and Underweight (44.5%) rates exceed NFHS-5, 2020 findings for Kolkata and the country. Even state wise reports of NFHS-5 only Bihar (stunting; 43.9% and underweight; 41.8%), Jharkhand (stunting; 42.2% and underweight; 41.4%), Uttar Pradesh (stunting;41.3%), Meghalaya (stunting; 48.2%) had higher stunting or underweight but lower than our finding.[14]

However, these reports likely underestimate the true extent of undernutrition. which was only revealed by estimating the Composite Index of Anthropometric Failure where 68.9% of children are suffering any form of anthropometric failure in our study population. A large number of studies done in various underserved pockets in West Bengal where their reported CIAF were either higher than our results or like our results, like Mondal et al found 73.1% in Hooghly district, Mukhopadhyay et al

and Shit et al found 69.1% and 80.3% respectively in Bankura district, Das et al found 66.3% in Purulia district, Sen et al found 63.6% in Darjeeling district.[15-19] But the most shocking part is all the above studies were done more than a decade ago even before the lunch of the biggest program in our country "Reproductive, Maternal, Newborn, Child plus Adolescent Health (RMNCH+A)". Additionally, neighbouring countries Bangladesh reported 48% of anthropometric failure among under five children from the Bangladesh Demographic Health Survey 2011(BDHS) data, whereas from Pakistan Demographic Health Survey 2012-2013 (PDHS) data showed about 44.4% of under-five children were stunted, 29.4% were underweight and 10.7% were wasted.[20,21] MacDonald CM et al reported in 2013 that children with anthropometric failure had a twelve times greater risk of early mortality, therefore measurement of CIAF is very useful.[22]

Further this study identifies factors contributing to childhood undernutrition in this slum. After considering all potential factors, low birth weight and the presence of repeated episode of cough and running nose are significantly linked to undernutrition. Approximately one-third (32.9%) of children had birth weights below the standard levels. Probably because of babies with low-birth-weight struggle to reach the catch-up growth according to age leads to a very large amount of stunting as well undernourishment in this study population. Studies done by Dasgupta et al in rural west Bengal and Khan et al in Pakistan also reported low birth weight as a risk factor for undernutrition among under-five children.[21,23]

It's challenging to determine if repeated episode of respiratory symptoms like cough & running nose directly contribute to undernutrition. It could be a two-way relationship where undernutrition increases susceptibility to respiratory illness, or poor immunization coverage (only 62.8% completely immunized) leads to frequent respiratory issues, making children vulnerable to undernourishment. Islam et al also reported the higher rate of child undernutrition may impact the higher burden of morbidity due to lower immunization, which results in higher rates of mortality among the affected children.[20]

Despite the presence of factors like early marriage, teenage pregnancy, pre-lacteal feeding, not exclusively breastfeeding, poor immunization, maternal pregnancy related complications and parental education, they did not emerge as predictors of undernutrition in our study probably because these factors were evenly distributed among both nourished and undernourished children.

Studying in hard-to-reach areas like slums offers insights into the neglected aspects of Kolkata and similar cities. However, our study had limitations. It lacked generalizability. Due to lack of outside comparison group this study unable to provide true skeleton of the area. Lastly, we could not claim the temporality of the associated factors.

CONCLUSION

The finding of this study suggests that over two-thirds of children under-five are undernourished in this specific setting. Undernutrition was more common among children with low birth weight and those experiencing repeated respiratory symptoms like cough and running nose. Despite poor feeding practices such as pre-lacteal feeding, lack of colostrum feeding, and inadequate breastfeeding, as well as low immunization coverage, these factors were not significantly linked to undernutrition. Additionally, prevalent maternal factors like early marriage, teenage pregnancy, home delivery, multiple births, short birth spacing, and unplanned pregnancies were not significantly associated with undernutrition in this population.

Recommendations

Firstly, the government and municipal corporation need to identify similar settings in cities and start a special campaign focusing on long-term nutrition support for children under-five. Maternal health education on family planning and promoting institutional deliveries are crucial. Additionally, all unvaccinated children should receive appropriate vaccinations, and communities should be encouraged to use public health facilities effectively. Strengthening nearby health facilities, including Integrated Child Development Services (ICDS) centres, is essential. Through a comprehensive qualitative examining to understanding complex interplay of sociodemographic, environmental and nutritional factors of the determinants of childhood undernutrition, policymaker, healthcare practitioners, and community stakeholders can formulate contextually relevant strategies to address this pressing public health issue and alleviate the suffering of vulnerable children in urban slums. Lastly, incorporating CIAF as a nutrition indicator and local nutrition programs should be seriously considered.

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Ethical approval: The study was approved by the Institutional Ethics Committee of All India Institute of Health and Hygiene (AIIH&PH), Kolkata (Number-AIIHPH/PSM/Protocol/2020-2023/038)

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