

# Assessment of under nutrition by composite index of anthropometric failure among under five children of brick kiln workers: A cross sectional study.

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## Abstract

**Introduction:** The Composite Index of Anthropometric Failure (CIAF) provides an overall magnitude of under nutrition in a population more comprehensively and also measures the severity of under nutrition by identifying children with multiple anthropometric failures. This study was conducted primarily to estimate proportion of stunting, wasting and underweight among children of brick-kiln workers aged six months to five years and the other objectives were to assess CIAF and association between different forms of malnutrition and few socio-demographic characteristics.

**Methods:** It was observational descriptive, cross sectional study. After obtaining informed consent from the parent of eligible children, the detailed history was obtained, anthropometry along with thorough physical examination of the child was carried out, details of which were entered in the proforma *i.e.*, 'Google form'. The data was analyzed using appropriate statistical methods.

**Results:** 90 children aged 6-59 months from brick kiln sites were enrolled. The study observed that wasting was significantly more in children below 24 months of age. Stunting was more common among children having higher birth order. The children of illiterate mothers were more underweight than literate mothers. 70% children had CIAF, whereas wasting, stunting, and underweight all together was seen in 24.44% study children. Only stunting was seen in 8.89% whereas, only wasting and only underweight was seen in 3.33% children.

**Conclusion:** All 3 parameters of under nutrition were higher and CIAF was alarmingly high (70%) topmost priority needs to be given to children who have all three forms of under nutrition.

**Keywords:** Children of brick kiln workers, Under nutrition, Composite Index of Anthropometric Failure (CIAF).

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## Introduction

India is the second largest brick producer in the world (1,40,000 brick units) after China, with an annual growth of 5%-10% [1]. Brick kiln workers are mainly seasonal migrant workers who migrate to the brick kiln sites with their families for six or more months. Their children are at increased risk of suffering from malnutrition because of various reasons such as restricted access to health services, lack/poor medical facilities, poverty, recurrent infections, lack of nutritious food, illiteracy, and ignorance about nutrition and health care etc., [2].

Under nutrition among children has been a public health threat; recorded in 2020, 149.2 million stunted under-five children and 45.4 million wasted children globally [3]. Globally, including in India, about 50% of under-five children mortality is attributable to under nutrition. Societal inequities and poverty are the main drivers for seasonal migration for livelihood, which in turn are major reasons for the commencement of under nutrition [4]. Age below five is very crucial because under nutrition at this age may cause permanent damage, and the child may be unable to attain her/his full potential later in life [5].

The second target under goal two of the sustainable development goal aims to end all forms of malnutrition in children under five years of age by 2030 which is challenging [6,7]. Various supplementary feeding programs exist in India, but they miss the migrant population, such as brick-kiln workers. The migratory nature of their occupation poses a hurdle in assessing the nutritional status of children of brick kiln workers and planning and implementing nutritional interventional programs [2].

Acute under nutrition results in wasting, whereas chronic malnutrition leads to stunting. The underweight is a combination of both stunting and wasting. Stunted children cannot attain their potential height, and their brains remain suboptimal in their cognitive functions. Hence, UNICEF and other international agencies focus on stunting. In 2000, Svedberg developed the Composite Index of Anthropometric Failure (CIAF), combining all three forms, *i.e.*, stunting, wasting, and underweight of under-nutrition. This index considers the weight-for-age, height/length-for-age, and weight-for-height/length to assess the nutritional status among children under five [8].

The A-Y subgroups under CIAF represent all permutations and combinations of the three forms of under nutrition. Group A represents normal children with no anthropometric failure. Group D constitutes children having all three forms. The CIAF is an excellent tool to measure the magnitude of early child under nutrition in the population. Hence, from a national policy and program perspective, the CIAF index would serve as an effective instrument for identifying the nutritionally most deprived groups given a higher risk of mortality in children with multiple nutritional deficiencies [9,10].

Studies assessing the nutritional status of children at brick kilns are few, and studies about CIAF are scarce. This study was conducted primarily to estimate the proportion of stunting, wasting, and underweight among children of brick kiln workers aged six months to five years from the field practice area of the rural health training center of a teaching hospital in the Pune district. The other objectives were to assess CIAF and the association between different forms of malnutrition and a few socio-demographic characteristics.

## Materials and Methods

### Study design

It was a descriptive, cross-sectional study.

### Setting

The authors conducted the study in the Rural Health Training Center (RHTC) field practice area of a private medical college in Western Maharashtra, India. The population of RHTC is 49,414 and it caters services to 13 villages. Six villages have brick kilns, and we selected them.

### Participants

Children of brick kiln workers aged 6 to 59 months and their parents were the participants.

### Inclusion and exclusion criteria

All the children of the specified age living at the brick kiln sites with their parents were eligible. A child suffering from acute illness was the only exclusion criterion.

### Sample size calculation

The percentage of stunting was considered 51.2%. The sample size was calculated using the following formula.

$$\text{Sample size 'n'} = Z^2 p^* q / d^2$$

Where,

Z=value associated with 95% confidence

p=percentage of stunting

q=100-p

d=10.24 (20% of p)

After putting all these values in the above formula, the minimum sample size was 88.

### Data collection and procedures

The study proforma was prepared and validated before study initiation. A Google form was prepared. The investigator trained the study team members on the study proforma completion, *i.e.*, 'Google form'. The eligible children from these brick-kiln sites whose parents consented to the study were enrolled consecutively till the desired sample size was reached. The brick kiln workers stay in temporary housing at the brick kiln sites; door-to-door visits were carried out by the medical interns under the supervision of the principal investigator, an associate professor in pediatrics, to identify potential study participants.

A detailed history, including breastfeeding and socio-demographic characteristics of the mother/child aged 6 to 59 months, was obtained. Anthropometry, along with a thorough physical examination of the child, was carried out, details of which were entered in the proforma, which was filled and uploaded on-site. The child's weight was measured in kilograms with a calibrated weighing scale nearest to 100 gm and height was measured by the standard technique using a stadiometer/infantometer to the nearest 1 cm.

### Study period

The study was conducted from March 2022 to December 2022.

### Statistical analysis

The data collected was entered in Excel and then analyzed in SPSS Version 28. Qualitative and discrete data are presented as numbers and percentages. Comparison of percentages of malnutrition between socio-demographic parameters by applying the chi-square test and p-value less than 0.05 was considered to be significant. We used the Venn diagram to depict the Composite Index of Anthropometric Failure (CIAF).

### Operational definitions

**Underweight:** Moderately underweight if weight for age between -2SD to -3SD and severely underweight if weight for age below -3SD [11].

**Stunting:** Moderately stunted if height/length for age between -2SD to -3SD and severely stunted if height/length for age below -3SD.

**Wasting:** Moderately wasted if weight for height/length between -2SD to -3SD and severely wasted if weight for height/length below -3SD.

### Composite Index of Anthropometric Failure (CIAF)

We considered all A-Y categories.

### Ethical consideration

The study was approved by the institutional ethics committee vide letter no. BVDUMC/IEC/1 dated 27 Jan 2021. The signed informed consent was obtained from the parents, preferably from the mother, and in the case of illiterate parents, the thumb impression of the parent and sign and date by the impartial witness were obtained before any study procedure.

### Results

We enrolled 90 children from 21 brick kiln sites. The average age of the children was 37.33 months (SD=15.47).

Table 1 shows some demographic characteristics of the enrolled children. The majority of children was more than two years of age and was of birth order  $\geq 2$ .

We have given age group-wise types of under nutrition in Table 2.

The highest CIAF of 84.2% was observed among children 13 to 35 months. The grading of type of under-nutrition is given in Table 3.

Table 3 shows the severity of malnutrition observed in our study, i.e., the proportion of severe grade was less than that of moderate grade of malnutrition.

Table 4 shows the association of age, sex, birth order, breastfeeding, and mothers' education with different forms of malnutrition. The study observed that wasting was significantly more prevalent in children below 24 months of age than in older children. Stunting was more common among children with higher birth order. The study also observed that children of illiterate mothers were underweight than literate mothers.

Variable	Attributes	Number (%)
Sex	Female	44 (48.9)
	Male	46 (51.1)
Age	<24 months	20 (22.2)
	$\geq 24$ months	70 (77.8)
Mother's education	Illiterate	49 (54.4)
	Literate	41 (45.6)
Birth order	1	29 (32.2)
	$\geq 2$	61 (67.8)
Exclusive breast feeding*	<6 m	21 (28.4)
	$\geq 6$ m	53 (71.6)

Note:\*. Data for 16 children regarding exclusive breast feeding could not be obtained.

Table 1. Demographic characteristics of the children of brick-kiln workers, Pune district.

Age groups	Number	Stunted	Underweight	Wasting	CIAF	
6 to <12 months	4	n	3	2	2	3
		%	75	50	50	75
13–35 months	38	n	28	26	16	32
		%	73.7	68.4	42.1	84.2
$\geq 36$ months	48	n	20	24	13	28
		%	41.7	50	27.1	58.3
Total	90	n	51	52	31	63
		%	56.7	57.8	34.4	70

Table 2. Under-nutrition indicators by age of the child.

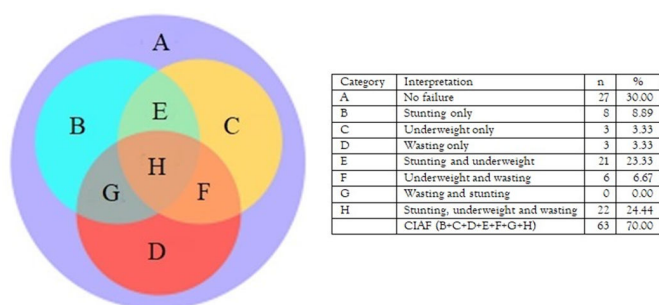
	Stunted	Underweight	Wasting
Category	n (%)	n (%)	n (%)
Moderate	31 (34.4)	31 (34.4)	16 (17.8)
Severe	20 (22.2)	21 (23.3)	15 (16.7)
Total	51 (56.6)	52 (57.7)	31 (34.5)

Table 3. Grades of malnutrition among children from brick-kiln sites, Pune district, India.

		Stunted			Underweight			Wasting			CIAF*		
Age		Yes	No	p	Yes	No	p	Yes	No	p	Yes	No	p
<24 months	Count	15	5	0.061	13	7	0.458	13	7	0.001	11	3	0.097
	%	75	25		65	35		65	35		55	15	
≥ 24 months	Count	36	34		39	31		18	52		11	24	
	%	51.4	48.6		55.7	44.3		25.7	74.3		15.7	34.3	
<b>Sex</b>													
Female	Count	28	16	0.192	27	17	0.501	16	28	0.708	34	10	0.141
	%	63.6	36.4		61.4	38.6		36.4	63.6		77.3	22.7	
Male	Count	23	23		25	21		15	31		29	17	
	%	50	50		54.3	45.7		32.6	67.4		63	37	
Birth order 1	Count	11	18	0.014	14	15	0.211	8	21	0.348	17	12	0.106
	%	37.9	62.1		48.3	51.7		27.6	72.4		58.6	41.4	
≥ 2	Count	40	21		38	23		23	38		46	15	
	%	65.6	34.4		62.3	37.7		37.7	62.3		75.4	24.6	
<b>Exclusive BF#</b>													
<6 months	Count	15	6	0.189	14	7	0.725	9	12	0.686	17	4	0.334
	%	71.4	28.6		66.7	33.3		42.9	57.1		81	19	
6-12 months	Count	29	24		33	20		20	33		37	16	
	%	54.7	45.3		62.3	37.7		37.7	62.3		69.8	30.2	
<b>Education</b>													
Illiterate	Count	30	19	0.34	33	16	0.045	20	29	0.164	36	13	0.432
	%	61.2	38.8		67.3	32.7		40.8	59.2		73.5	26.5	
Literate	Count	21	20		19	22		11	30		27	14	
	%	51.2	48.8		46.3	53.7		26.8	73.2		65.9	34.1	

**Table 4.** Association of demographic characteristics with categories of malnutrition. **Note:** \*: CIAF=Composite Index of Anthropometric Failure; #: BF=Breast Feeding.

In our study, as shown in the Figure 1, Venn diagram, 63 (70%) children had CIAF, whereas wasting, stunting, and being underweight were seen in 22 (24.44%) study children. Only stunting was seen in 8.89%, whereas only wasting and underweight were seen in 3.33% of children.



**Figure 1.** CIAF among under five children at brick kiln sites.

## Discussion

This study was carried out to assess the magnitude and type of under nutrition among highly neglected children aged six to 59 months of brick kiln workers from rural areas. Most of these workers were migrant laborers from very low socio-economic strata. A high prevalence of under nutrition and high morbidity among children who accompany their parents during seasonal migration is usually observed. This may be due to recurrent interruption of critical health services and also attributed to

unhygienic living conditions in many work sites which may leave children vulnerable to illness and malnutrition [4].

A study of under-five children of migrant workers at construction sites from Ahmadabad showed that under-nutrition was highly prevalent among the children, *i.e.*, 40.5% were stunted, 22.1% were wasted, and 50.4% were underweight [12]. In the 2023 global hunger index, India's rank has dropped to 111 out of the 125 countries. The Global Hunger Index (GHI) is a tool for comprehensively measuring and tracking global, regional, and national hunger. GHI scores are based on the values of four component indicators, *i.e.*, undernourishment, child stunting, child wasting, and child mortality of children under the age of five years [13].

We feel that including the underweight category in GHI (representing all three under-nutrition forms) may be more comprehensive. The Comprehensive Index of Anthropometric Failure (CIAF) has been proposed to provide a more complete picture of under nutrition at the population level [6]. As reported by many previous studies, the CIAF is a more important tool than other conventional methods to assess simultaneous anthropometric failures [6,9,14-17]. The meta-analysis of the effects of malnutrition in low-and-middle-income countries has shown that children with all three failures, *i.e.*, CIAF category D, have the highest risk of mortality among the undernourished children, a combination of two failures, wasted and underweight, *i.e.*, CIAF category C

was reported more hazardous than being stunted and underweight, *i.e.*, CIAF category E [9].

Malnourished children do not attain their optimum potential in terms of growth and development, physical capacity to work, and economic productivity in the later phase of life, so it's essential to combat malnutrition in the early years [5]. In our study, all three parameters of nutritional assessment, *i.e.*, stunting, wasting, and underweight, were markedly higher as compared to data from NFHS 5 from the Pune district, which shows that 30.7% children were stunted, 31.4% wasted, and 32.7% were underweight [18]. The magnitude of malnutrition was also higher than that of children under five years of brick kiln workers from the Bhaktapur district in Nepal [19]. The Composite Index of Anthropometric Failure (CIAF) in our study was observed in 63 (70%) children, much higher than reported in many previous studies [14,15,20-22].

Ramendra Nath Kundu and colleagues have reported that more than half of the under-five children (52.18%) in India are suffering from AF. The rate of AF is more than that of other countries like Bangladesh (48.30%), and Tanzania (38.20%), and lesser than that recorded in rural Yemen (70.10%) [23]. In another study, the prevalence of wasting across the six 'South Asian' countries considered in their analysis ranged from 9% in Afghanistan to 21% in India. According to WHO thresholds, a level above 10% represents a serious public health emergency, and rates above 15%, as in India, amount to a critical situation [24].

In our study, the stunting, underweight, and CIAF were higher in children less than two years of age, which may be due to insufficient complementary feeding and recurrent infections in younger children. The wasting was also significantly more in children below two years of age than in older children, *i.e.*, p-value 0.001, similar to some other studies. (8,16,25). The prevalence of stunting has been shown to be higher in children below two years in a study by Rehan et al., [24]. In contrast, few previous studies have reported a higher proportion of stunting in children above 24 months [16,26].

A study from Nepal has shown that the likelihood of children being wasted decreased sharply from birth to around 30 months of age and increased rapidly after that until 59 months [27]. A study carried out in Pune city slums showed no significant relationship between stunting and wasting with the age of a child but has reported that as age increased, the proportion of children underweight also increased [28]. In our study, moderate-grade malnutrition was more common than severe grade.

The malnourishment was observed more in females, though it wasn't statistically significant. Under nutrition was also reported more in females at brick kiln sites in Bhaktapur district, Nepal [18]. In a few previous studies, male children were found at a greater risk of being undernourished [4,15,24,26,29], whereas few researchers have reported no significant gender difference in malnutrition [28,30].

In our study, children of illiterate mothers were more malnourished, but it was statistically significant only for

underweight children, *i.e.*, p-value 0.045. Many authors have reported a higher prevalence of malnutrition in children of illiterate mothers [5,20,23,25,28,29,31-34]. This study showed that children with birth order  $\geq 2$  were more likely to be malnourished. Still, it was statistically significant only for the stunting, *i.e.*, p-value 0.014, similar to the study by Kundu et al., [22]. Malnutrition in children who received exclusive breastfeeding for at least six months was less. However, it was not statistically significant; many previous authors have shown this. [3,8,31,33,34]

As shown in the venn diagram, our study has shown that the percentage of 'only' underweight, wasting, or stunting is meager as the majority of these children have multiple categories of malnutrition.

## Conclusion

A large proportion of the children of brick kiln workers have all three forms of under nutrition. The Comprehensive Index of Anthropometric Failure (CIAF) was high as 70%. The community has to frame a robust policy to take care of these highly vulnerable children. Topmost priority needs to be given to children who have all three forms of under nutrition. Hence, CIAF was very helpful in giving us an accurate picture of the nutritional status of these children. Apart from brick kiln workers' children all who exhibit all three forms of under nutrition needs highest priority.

## Limitations

We did not collect information about diet. The sample size was small and represented only one block of Pune district.

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## Conflict of interest

None declared.

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