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Assessment of the Composite Index of Anthropometric Failure (CIAF) among the Rural Preschool Children of Medinipur, West Bengal

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Abstract

Background: According to the WHO Global Report (2020), 45 percent of deaths among preschool children are linked to undernutrition. In the Indian context, the National Family Health Survey (NFHS), 2022 reports that 19 percent, 36 percent, and 32 percent of children are wasted, stunted, and underweight, respectively. This report was published 47 years after the establishment of the Integrated Child Development Service (ICDS). Therefore, it can be concluded that the objectives of the ICDS have not been satisfactorily fulfilled.

Aims & Objective: The present study was designed to assess overall undernutrition among rural preschool children in Medinipur, West Bengal, India, using the Composite Index of Anthropometric Failure (CIAF).

Materials & Methods: In this cross-sectional study, 303 preschool children were examined, comprising 146 boys and 157 girls, aged 2-5 years, residing in the rural villages of Medinipur Sadar block. Two anthropometric variables, height (cm) and weight (kg), were collected through standard anthropometric procedures. Undernutrition indicators, including height-for-age, weight-for-age, and height-for-weight Z-scores, were calculated using WHO's 2006 cutoff values. If any value was found to be < -2 standard deviations (SD), it was considered undernutrition, and the condition was termed wasting, stunting, or underweight, respectively. Subsequently, all these failures were evaluated using CIAF (Svedberg and Nandy, 2005).

Results: The overall prevalence of wasting, stunting, underweight, and CIAF are 20.5 percent, 65.0 percent, 57.1 percent, and 76.9 percent, respectively. Girls exhibit a higher prevalence of stunting, underweight, and CIAF compared to boys, and these differences are statistically significant ($p < 0.05$ and $p < 0.001$). There is a significant difference in height-for-age (HAZ) by sex. Out of the 303 respondents, 233 (76.9 percent) fall under the CIAF category, with 54.0 percent of girls classified as malnourished (B-Y).

Conclusion: This study reveals that 3-year-old girls are the most vulnerable to all anthropometric failures, while boys across all age groups are less prone to failures compared to girls. The total anthropometric failure rate remains at 76.9 percent, representing a very serious condition. Urgent intervention is needed to evaluate the health infrastructure provided by various health services, such as ICDS, and to conduct awareness programs that educate parents about caring for their child's healthy future.

Keywords: Rural Preschool Children, Composite Index of Anthropometric Failure, Anthropometric Measurements, Wasting, Stunting, Underweight.

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Introduction:

As defined by the World Health Organization (WHO), health is "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1998). Health and nutrition are closely intertwined because a healthy body relies on good nutrition, which refers to the substances you consume as food and how they impact your health (Cambridge Dictionary). Nutrition plays a critical role in health and development. Better nutrition is associated with improved infant, child, and maternal health, stronger immune systems, safer pregnancy and childbirth, a reduced risk of non-communicable diseases like diabetes and cardiovascular disease, and increased longevity (WHO, 1999).

Children are the main asset of a country, so children's health is a priority because a healthy child means a good workforce. It involves four components: Child Survival, Child Development, Child Protection, and Child-Centered Community Participation. With the birth of 25 million children each year, India accounts for nearly one-fifth of the world's annual childbirths; every minute, one of those babies dies (UNICEF India, 2013). The latest edition of the Global Nutrition Report 2018 addressed that India tops the number of stunted children (46.6 million).

"Pre-school" is a significant period that occurs before a child enrolls in the formal education system. Children represent the most vulnerable segment of any community. A recent study published in The Lancet found that malnutrition was the primary cause of death among preschool children under five years old in every Indian state in 2017, accounting for 68.2 percent of total deaths in this age group (Swaminathan et al., 2019). The latest round of the Indian Family and Health Survey reveals that at the national level in 2015-16, approximately 38 percent were stunted, 21 percent were wasted, and 36 percent were underweight (NFHS, 2017).

The preschool phase occurs before a child enters the formal education system. India, with the highest population in the world, places preschool children (1-6 years) as one of the most crucial segments of our population. Among children, undernutrition is assessed using the following parameters: wasting (low weight for height/WHZ), underweight (low weight for age/WAZ), stunting (low height for age/HAZ), and the Composite Index, also known as the Composite Index of Anthropometric Failure (CIAF) (WHO, 1995). We are all aware that proper nutrition and undernutrition are like two sides of a coin. Proper nutrition leads to healthy children, while undernutrition results in malnourished children. The term "malnutrition" encompasses both undernutrition and overnutrition, affecting children who are either undernourished or overnourished. In most parts of the world, malnutrition primarily manifests as undernutrition, which is defined as the result of insufficient food intake and repeated infectious diseases (UNICEF, 2006).

Wasting is defined as low weight-for-height. It often indicates recent and severe weight loss, although it can also persist over a long time. It typically occurs when an individual has not had access to food of sufficient quality and quantity, and/or they have experienced frequent or

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prolonged illnesses. Wasting in children is associated with a higher risk of death if not treated properly (Cambridge Dictionary, 2009).

Stunting is defined as low height for age. It results from chronic or recurrent undernutrition and is usually linked to factors such as poverty, poor maternal health and nutrition, frequent illness, and inappropriate feeding and care during early life. Stunting prevents children from reaching their physical and cognitive potential (WHO, 2015).

Underweight is defined as low weight-for-age. An underweight child may be stunted, wasted, or both. Micronutrient deficiencies are due to a lack of vitamins and minerals that are needed for the body's proper functioning (WHO, 2015).

Many CIAF studies have been conducted in various states and regional areas, but very few have been carried out in the rural area of Medinipur Sadar block. While Sinha et al. (2012) conducted a cross-sectional study with a specific focus on preschool children in Medinipur Town, this present study particularly aims to determine the prevalence of undernutrition based on CIAF among preschool children in the remote rural area of Medinipur.

Materials & Methods: This cross-sectional study was conducted in nine villages: Bagdubi, Lodhasai, Jharnadanga, Jamsol, Chand Bhuiasol, Gopegarh, Gabnala, Phulpahari, and Amratala, within the Kankabati gram panchayat of Medinipur block, West Bengal, India. This area, located in the Paschim Medinipur district, is situated at an elevation of 23 meters above sea level and is 127 km west of Kolkata. The total area under study covered 35.97 sq km. With a prevalence of CIAF estimated at 59.8 percent (Nandy et al., 2012), a 95 percent confidence level, 15 percent relative precision, and a 5 percent nonresponse rate taken into consideration, the sample size was determined to be 121. The total number of participants in this study was 303, consisting of 146 males and 157 females aged between 2 and 5 years. Data collection took place from March 23, 2022, to May 5, 2022. Before taking anthropometric measurements, the parents of the children were informed about the study's objectives. After understanding the objectives, they provided verbal consent to participate. Data was collected through a structured questionnaire by door-to-door visits.

Nutritional Status Assessment:

All anthropometric measurements were taken using standard procedures (Lohman et al., 1988). Two anthropometric measurements, weight (kg) and height (cm), were taken from the preschool children in the respective villages of Medinipur. The nutritional status of the studied children was assessed using age- and sex-specific Z-scores, which indicate stunting (low height for age), wasting (low weight for height), and underweight (low weight for age) as recognized by the World Health Organization (WHO, 2006). Age- and sex-specific -2 Z-scores were employed to define stunting, underweight, and wasting. The Z-scores were calculated using the standard formula: Z score = (X – Median of WHO, 2006) / (Standard deviation of WHO, 2006), where X

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represents the specific score of height, weight, or circumference of a child. Children whose Z score was < -2 SD were considered malnourished, and those with Z scores between -2 and +2 SD were categorized as normal. The WHO (1995) provided the classification of Z-score cut-off points for children: < -2 SD Z score = Undernutrition, -2 to +2 SD Z score = Normal, and > +2 SD Z score = Overnutrition.

The Composite Index of Anthropometric Failure (CIAF) provides an alternative and holistic perspective on malnourished children compared to other conventional methods like stunting, underweight, and wasting. CIAF was first introduced by Svedberg (2000). This model includes six groups: no failure, stunted only, wasted, wasting and underweight, stunted and underweight, and stunted, wasted, and underweight. After five years, Nandy et al. (2005) included an additional category named Y (underweight only). In this study, the CIAF is computed according to Nandy et al. (2005), which has seven categories: A) no failure, B) wasting only, C) wasting and underweight, D) wasting, underweight, and stunting, E) stunting and underweight, F) stunting only, and Y) underweight only. (**Table 1**).

Table 1: Classification of CIAF developed by Svedberg et al. 2005

Groups name	Description	Stunting	Wasting	Underweight
A	No Failure	-	-	-
B	Wasting only	-	*	-
C	Wasting & underweight	-	*	*
D	Wasting, stunting & underweight	*	*	*
E	Stunting & underweight	*	-	*
F	Stunting only	*	-	-
Y	Underweight only	-	-	*

Statistical analysis: All data entry and inferential statistics, such as ANOVA and Chi-square tests, were performed using SPSS (version 25.0). Microsoft Excel and Word were used for graphs and report typing purposes, respectively. The significance levels of all anthropometric variables were observed at $p < 0.05$ and $p < 0.001$.

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Results and Discussion

Table 2 discusses age-specific, sex-combined mean height and weight of the studied respondents. It was found that with increasing age, height and weight also increased across different age groups for both sexes, which was statistically significant ($p<0.001$); for boys $F=31.440$, and for girls $F=29.646$. Generally, it was found that girls and boys had almost similar mean heights across all age groups, but the table shows that boys are taller than girls except at age 2.

Table 2: Age-specific mean and standard deviation of anthropometric variables

	Girls			Boys			
Age in years	N	Mean	SD	N	Mean	SD	T-value
2	13	88.5	10.2	14	85.5	8.9	0.8
3	50	86.8	7.0	44	90.2	6.8	-2.3
4	45	94.5	4.9	44	95.4	5.9	-0.8
5	49	98.3	5.5	44	101.7	6.4	-2.7
Age combined	157	92.7	7.9	146	94.8	8.5	-2.1
ANOVA	F= 29.646***			F= 31.440***			

Source: The Authors. SD- Standard Deviation; N- Number of individuals; *** indicates $p<0.001$ level of significance in the case of height and weight.

Table 3 presents the sex-wise overall prevalence of malnutrition. This study reveals that among the 303 children examined, 20.5 percent are experiencing wasting, with 22.6 percent of boys and 18.5 percent of girls affected. Additionally, 57.1 percent of the study respondents are underweight, with 61.1 percent of girls and 52.7 percent of boys affected. Stunting affects 65.0 percent of the children, with 70.7 percent being girls and 58.9 percent boys. Stunting shows a significant difference ($p<0.05$) between the sexes. The CIAF is 76.9 percent, with 84.1 percent of girls and 74.0 percent of boys experiencing anthropometric failures.

Table 3: Sex-wise prevalence of undernutrition based on wasting, stunting, underweight, and CIAF among preschool children

Malnutrition Indicator	Girls (N-157)	Boys (N-146)	Total (N-303)	Sex difference (χ^2)
Wasting	29 (18.5)	33 (22.6)	62 (20.5)	0.3; df-2
Underweight	96 (61.1)	77 (52.7)	173 (57.1)	0.1; df-2
Stunting	111 (70.7)	86 (58.9)	197 (65.0)	0.0*; df-2
CIAF	128 (81.5)	105 (71.9)	233 (76.9)	0.0*; df-2

Source: The Authors. N- Number of individuals; * Indicates $p<0.05$ level of significance in case of stunting and CIAF among preschool children.

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Table 4 discusses the classification of anthropometric failure among the study participants. The children are distributed into seven categories percentage-wise. Among the 303 study participants, 23.1 percent did not have any failure, with 44.28 percent being girls and the remaining boys; this group is denoted as 'A', signifying no failure. In this group, 2-year-old girls exhibit the highest prevalence of no failure, while 3-year-old girls show the least within the age and sex combined.

Group B (wasting only) includes 2.31 percent of children, which is very low among all the groups. Among this group, 60.0 percent are boys, and the rest are girls. In this group, 3-year-old boys have the highest wasting failure, while 2- and 4-year-old boys and girls have the least within the age and sex combined.

In **Group C** (wasting + underweight), 2.97 percent of children have this failure, which is the second lowest among all the groups. Among this group, 66.33 percent are boys, and the rest are girls. In this group, 3- and 4-year-old boys have the highest prevalence of this failure, while 5-year-old girls have the least within the age and sex combined.

Group D (wasting + underweight + stunting) represents the most critical category from a malnutrition standpoint. 16.50 percent of children exhibit multiple failures, ranking as the third-highest among all the groups. Within this group, 46.0 percent are boys, and the rest are girls. In this group, 3-year-old girls had the highest multiple failures, while 3- and 5-year-old boys and girls had the least within the age and sex combined.

In **Group E** (stunting + underweight), 35.31 percent of children have multiple failures, the highest among all the groups. Among this group, 56.07 percent are girls, and the rest are boys. In this group, 3-year-old girls have the highest multiple failures, while 2-year-old girls have the least within the age and sex combined.

In **Group F** (stunting only), 14.52 percent of children have this failure. Among this group, 56.8 percent are girls, and the rest are boys. In this group, 4- and 5-year-old girls and boys have the highest failure, while 2-year-old boys and girls have the least within the age and sex combined.

In **Group Y** (underweight only), 5.28 percent of children have this failure. Among this group, 50 percent are girls, and the rest are boys. In this group, 4- and 3-year-old girls have the highest prevalence of this failure, while 4-year-old boys and girls and 3-year-old boys have the least within the age and sex combined.

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Table 4: Age and sex-wise prevalence (%) of the composite index of anthropometric failure among preschool children
Source: The Authors.

Groups	Age in years								Age sex combined	Total (233)
	2 (N-27)		3 (N-94)		4 (N-89)		5 (N-93)			
	Girls (N-13)	Boys (N-14)	Girls (N-50)	Boys (N-44)	Girls (N-45)	Boys (N-44)	Girls (N-49)	Boys (N-44)	N- 303	
A	5(38.4)	4(28.5)	5(10.0)	10(22.7)	11(24.4)	11(25.0)	10(20.4)	14(31.8)	70 (23.1)	30.0
B	1 (7.6)	-	-	4 (9.0)	-	1 (2.2)	1 (2.0)	-	7 (2.3)	3.0
C	-	-	2 (4.0)	3 (6.8)	-	3 (6.8)	1 (2.0)	-	9 (2.9)	3.8

N- Number of individuals

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D	-	-	12(24.0)	7 (15.9)	8 (17.7)	8 (18.1)	7 (14.0)	8 (18.1)	50 (16.5)	21.4
E	2(15.3)	6(42.8)	25(50.0)	14(13.8)	15(33.3)	18(40.9)	18(36.7)	9 (20.4)	107 (35.3)	45.9
F	5(38.4)	1 (7.1)	2 (4.0)	5 (11.3)	10(22.2)	3 (6.8)	8 (16.3)	10(22.7)	44 (14.5)	18.8
Y	-	3(21.4)	4 (8.0)	1 (2.27)	1 (2.2)	1 (2.2)	3 (6.1)	3 (6.8)	16 (5.2)	6.8
CIAF (B-Y)	8(61.5)	10(71.4)	45(90.0)	34(77.2)	34(75.5)	34(75.5)	38(77.5)	30(68.1)	233 (76.9)	

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The CIAF serves as an alternative indicator for assessing malnutrition, as conventional indicators like stunting, wasting, and underweight offer valuable insights into specific biological processes but fail to present a comprehensive view of the overall malnutrition burden among young children (Nandy & Svedberg, 2012). To obtain a more holistic understanding of malnutrition, it is recommended to utilize CIAF in measuring the nutritional burden among preschool children (Biswas & Khatun, 2023; GS Boregowda et al., 2018; Kramsapi et al., 2018). Therefore, in the present study, CIAF is employed to identify the prevalence of the overall malnutrition burden in preschool children.

Table 5 discusses the prevalence of anthropometric failure in state and regional studies conducted by different scholars. These studies are compared with the present study to identify any trends in anthropometric failure. It was observed that the highest prevalence of anthropometric failure was found by Taladpalliwar et al. (2014) in their study, which was 76.3 percent, almost equal to the present study's 76.9 percent. The least anthropometric failure was found by Roy et al. (2018), at 36.1 percent. The present study found the highest percentage of anthropometric failure at 76.9 percent. It is also observed that the CIAF percentage is the highest among other malnutrition indicators in all the studies mentioned in **Table 5**. Regarding stunting, the highest percentage, 60.9 percent, was observed in the study conducted by Taladpalliwar et al. (2014), which is lower than the present study's percentage of 65.0. Mandal & Bose et al. (2009) found the highest percentage of wasting, 50.0 percent, which is considerably higher than the present study's 20.5 percent. Taladpalliwar et al. (2014) recorded the highest percentage of underweight, 66.4 percent, which is higher than the present study; the lowest percentage, 3.0 percent, was observed in a study by Bahuguna et al. (2021). The limitation of the present study is the small sample size, which is only representative of a part of a community, not the whole district of Paschim Medinipur or the state of West Bengal. Consequently, it cannot provide a comprehensive overview of the prevalence of malnutrition among preschool children in Paschim Medinipur and West Bengal as a whole.

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Table 5: Comparison of Wasting, stunting, underweight, and CIAF with other studies.

Previous Studies	Study area	N	Age in years	Prevalence			
				Stunting (%)	Under Weight (%)	Wasting (%)	CIAF (%)
Biswas et al., 2023	Jalpaiguri	607	2-5	19.76	36.5	28.8	46.6
Swarnakar et al., 2022	Raipur	100	2-5	26.0	23.0	19.0	42.0
Bahuguna et al., 2021	Mumbai	6489	5>	14.8	3.0	1.7	52.2
Ghritlahre et al., 2021	Chhattisgarh	502	2-5	38.2	37.0	19.5	56.1
Mandal et al., 2021	Hooghly	618	3-8	32.5	57.1	40.5	66.3
Barali et al., 2019	Assam	362	0-5	36.2	22.9	11.6	48.6
Titoria et al., 2019	Delhi	265	<5	44.5	35.4	26.7	60.3
Kramsapi et al., 2018	Assam	400	2-5	35.50	26.7	18.5	51.0
Biswas et al., 2018	South 24 pargana	656	3-5	26.2	51.1	35.4	61.3
Roy et al., 2018	Rural children of West Bengal	142	<5	16.7	29.2	22.7	36.1
Dhoka et al., 2016	Nagpur	256	<5	34.8	45.3	15.2	58.6
GS Boregowda et al., 2015	Raipur, Chhattisgarh	602	1-3	46.6	45.2	17.8	62.1
Gupta et al., 2015	Haryana	938	0-5	46.2	25.3	9.5	53.1
Dewan et al., 2015	Jammu	250	0-5	42.8	38.8	20.4	73.2
Agarwal et al., 2015	Agra	458	0-5	41.9	42.8	22.7	60.0
Dasgupta et al., 2014	Singur	113	5>	15.0	17.7	17.7	32.7
Taladpalliwar et al., 2014	Central India	540	0-5	60.9	66.4	18.8	76.3
Acharya et al., 2013	Purba Medinipur	225	3-6	30.7	42.7	12.0	50.2
Sinha et al., 2012	Midnapore	658	2-6	40.6	43.8	23.4	58.2
Kumar et al., 2010	Allahabad	371	0-5	40.7	49.1	24.6	62.8
Mandal et al., 2009	Hooghly	1012	2-6	26.6	63.3	50.0	73.1
Nandy et al., 2005	State-wise, India	24,395	0-5	45.1	47.1	15.9	59.8
Present Study	Medinipur	303	2-5	65.0	57.1	20.5	76.9

Source: The Authors. N- Number of individuals

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Conclusion: This study concludes that the nutritional status of the study groups was not satisfactory. It reveals that 3-year-old girls are the most vulnerable to all anthropometric failures, while boys from all age groups are comparatively less affected. The total prevalence of anthropometric failure is 76.9 percent, the highest among all previous studies discussed. Therefore, urgent intervention is needed to evaluate the health infrastructure provided through various health services like ICDS. In rural areas, health and nutrition are often given the least priority, as observed in the present study. We suggest that the competent authority organize awareness programs to educate parents about caring for their child's health for a better future.

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