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A community-based cross-sectional study on the nutritional status of children less than 5 years of age using Composite Index of Anthropometric Failure in a semi-urban area of northern Tamil Nadu

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ABSTRACT

Malnutrition among under-five children is a major public health problem all around the world. About more than 30% of the malnutrition world-wide is prevalent in southern Asia, a significant proportion of which is contributed by India. It is well known that malnutrition is frequently a part of a vicious cycle that includes poverty and infections, which can last a life-time and may also affect the next generations. This study aims to assess the nutritional status of children less than 5 years in a semi-urban area of Tamil Nadu using a composite index of anthropometric failure. A cross-sectional community-based study was undertaken among 168 children and anthropometric measurements were taken. Using conventional Z score indicators, 22.62% of the children were found to be stunted, 43.45% of the children were underweight and wasting was found in 45.83% of the children. Whereas using CIAF, the results were found to be 38.69% (no failure), 11.90% (Only wasting), 23.21% (Wasting and underweight), 11.31% (Wasting, underweight and Stunting), 6.55% (Stunting and underweight) 5.36% (Only stunting) and 2.98% (Only underweight). There was an unacceptably high prevalence of malnutrition among under-five children. Therefore, using CIAF showed better classification of undernutrition than conventional indicators. Also, health institutions at all levels should integrate nutrition as a health component and there is a need to educate the parents to provide age-appropriate energy-rich, locally available and nutritionally balanced food items. Accelerating the reduction in under-5 mortality is possible by expanding effective preventive and curative interventions that target the main causes of undernutrition. This will, in the long run, help in making this nation healthier, stronger, and more prosperous.

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INTRODUCTION

The health and education of its people determine the future strength of a nation. Also, the developmental status of each country is judged worldwide on the basis of the nutritional status of its people (Acharya *et al.*, 2013). Nutrition plays a crucial role in child survival, growth, development and, thus, to play, learn, participate and grow - while malnutrition deprives the child of their abilities (Biswas *et al.*, 2018). Malnutrition is a nutritional disorder caused either by a lack or surplus or imbalance of nutrients in a person's body (Hasan, 2010). So, it

includes both undernutrition and nutrition.

Under nutrition is a consequence of lack of consumption of essential nutrients or their rapid usage and includes stunting (short for age), underweight (low weight for age) and wasting (thin for height). Malnutrition, in its several forms of under-nutrition, has been coined as the "silent emergency" by the United Nations children's fund (UNICEF) (Priyanka *et al.*, 2016). Overnutrition results from eating too much and too many of the wrong things, not exercising enough and taking many more vitamins or other dietary supplements than needed. It includes overweight (BMI between 25 and 29.9) and obesity (BMI over 30).

One of the most serious health problems among children under 5 years of age in developing countries is malnutrition (Bharati *et al.*, 2008). Totally 47% of Indian children were (> 5 years of age) are malnourished (World Bank report of 2005). It is the underlying cause of 3.5 million deaths and 35% of the disease burden in children in this age group all over the world (Black *et al.*, 2008). It is also a major cause of child mortality in India. Chronic undernutrition in childhood is highly interconnected with slower cognitive development and serious health deterioration and damage later in life, which reduces the quality of life and also the economic productivity of people (Acharya *et al.*, 2013), thereby decreasing the economic productivity of the entire nation. Conventional anthropometric parameters and CIAF are used to verify the incidence of undernutritionn in the study population. The three conditions that can be assessed by using anthropometric measurements are stunting by measuring height, underweight by measuring weight and wasting by measuring mid-arm circumference.

Stunting reflects a failure to reach linear growth potential due to sub-optimal health and or nutritional conditions. Underweight indicates low body mass, relative to chronological age influence by both the child's height and weight. Wasting is an indicator of chronic undernutrition resulting from prolonged nutritional deprivation. Wasting may also occur in cases of any chronic disease or illness. These three measurements have clinically different indications. But these measurements include all the undernourished children in single categories, not considering which of the three conditions or a combination of these three conditions. This led to the construction of CIAF - Composite Index of Anthropometric Failure, which has the distinct advantage of highlighting the seriousness and severity of a population's overall undernutrition more thoroughly and precisely than the three individual conventional measures (Goswami, 2016). CIAF provides a composite estimate of the number of undernourished children in a population not indicated by the conventional indices, and thus, is more practical and effective.

Therefore, the present study focuses on the composite index of CIAF to evaluate the overall prevalence of undernutrition among children under five in a semi-urban area of northern Tamil Nadu.

MATERIALS AND METHODS

This is a community based cross-sectional study, which was conducted in the urban field practice area of Tertiary Medical college hospital of northern Tamil Nadu for a period of 6 months from January 2019 to June 2019, after obtaining ethical clearance from the institutional ethical clearance board. The study population comprised of children between 6 months and 5 years of age. The sample size required in estimating proportion (prevalence)was calculated with anticipated population proportion (p) as 29% with 95% confidence interval and at a 5% significance level, including 10% non-responsive cases, sample size derived from being 168. A multi-stage sampling (2stages) method was used to enroll in the study subjects.

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Stage 1: 'Selection of wards'

According to the Census of India, Thiruvallur Town Panchayat is divided into 15 wards (Chennai City Census 2011 data). It covers a total population of around 20,000. Out of these, 3 wards were chosen by using simple random sampling using the lottery method

Stage 2: 'Selection of the study population from wards'

Children under five years of age were selected from 3 wards. In each ward 90 children were chosen from the family household survey register maintained in the urban health care center of a tertiary care medical college hospital using simple random sampling techniques using computer-generated random numbers. The data was collected using a pretested semi-structured questionnaire, which consisted of three parts. Part 1 included socio-demographic details like gender, age, socio-economic status, birth weight and order. Part 2 included nutritional habits like exclusive breastfeeding, complementary feeding, immunization status and utilization of Anganwadi services. Part 3 included anthropometric measurements (includes height, weight and mid-arm circumference) according to WHO standards.

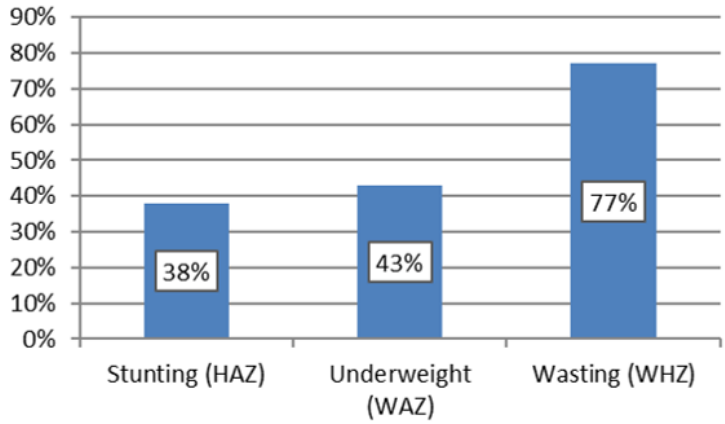

Figure 1: Prevalence of undernutrition using conventional Z scores indices

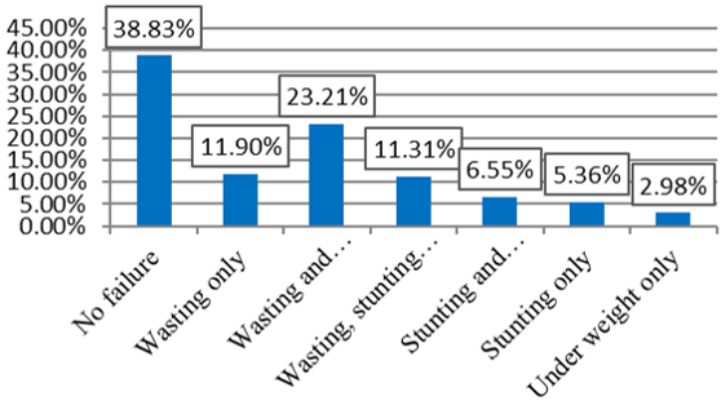

Figure 2: Prevalence of undernutrition using the Composite Index of Anthropometric Failure

Table 1: Classification of Composite Indices of Anthropometric Failure (CIAF)

CIAF Category	Stunting	Underweight	Wasting
No failure	No	No	No
Wasting only	No	No	Yes
wasting and underweight	No	Yes	Yes
Wasting, underweight and stunting	Yes	Yes	Yes
Stunting and underweight	Yes	Yes	No
Stunting only	Yes	No	No
Underweight only	No	Yes	No

Table 2: Association of Socio demographic variables with Conventional Z score indices

Variables	H/A 2SD	H/A 3SD	W/A 2SD	W/A 3SD	W/H 2SD	W/H 3SD
			Age			
Less than 2 years	7 (4.16)	0	3 (1.78)	5 (2.97)	7 (4.16)	5 (2.97)
More than 2 years	14 (8.33)	17 (10.1)	28 (16.6)	37 (22.02)	27 (16.07)	39 (23.2)
p value	0.647	0.001*	0.012*	0.000*	0.174	0.009*
			Birth Weight			
< 2.5 kgs	8(4.76)	11(6.54)	13(7.73)	31(18.45)	16(9.52)	29(17.26)
>2.5 kgs	13(7.73)	6(.57)	18(0.71)	11(6.54)	17(10.11)	15(892)
p value	0.815	0.069	1.000	0.000*	0.438	0.000*
			Birth Order			
1	6(3.57)	0	13(7.73)	7(4.16)	19(11.31)	9(5.35)
2	15(8.92)	16(9.52)	16(9.52)	35(20.83)	12(7.14)	35(20.83)
3	0	1(0.59)	2(1.19)	0	2(1.19)	0
p value	0.163	0.001*	0.632	0.000*	0.094	0.000*
			Socio- economic Classification			
Middle Class	5(2.98)	2(1.19)	1(0.59)	6(3.57)	1(0.59)	5(2.98)
Lower Middle Class	11(6.55)	5(2.98)	16(9.52)	17(10.11)	14(8.33)	16(9.52)
Lower Class	5(2.98)	10(5.95)	14(8.33)	19(11.30)	18(10.71)	23(13.69)
p value	0.005*	0.510	0.347	0.270	0.448	0.536
			Gender			
Boys	6(3.57)	6(3.57)	18(10.71)	15(8.92)	19(11.31)	21(12.5)
Girls	15(8.92)	11(6.54)	13(7.73)	27(16.07)	14(8.33)	23(13.69)
p value	0.019*	0.129	0.691	0.021*	0.698	0.384
			Feeding Practices at first 6 months			
EBF	15(8.93)	15(8.93)	27(16.07)	40(23.81)	29(17.26)	43(25.59)
Mixed BF	3(1.79)	2(1.19)	4(2.38)	2(1.19)	4(2.38)	1(0.59)
Formulae feed	3(1.79)	0	0	0	0	0
p value	0.200	0.337	0.084	0.053	0.086	0.017*
			Complementary Feeding			
At 6 months	14(8.33)	7(4.16)	21(12.5)	20(11.90)	21(12.5)	20(11.9)
6 – 12 months	7(4.16)	10(5.95)	10(5.95)	22(13.09)	12(7.14)	24(14.28)
p value	0.814	0.061	0.682	0.016*	1.000	0.006*
			No of illness episodes in last 6 months			
Less than 2 episodes	9 (5.35)	5 (2.97)	16 (9.5)	3 (1.73)	20 (11.9)	9 (5.39)
More than 2 episodes	12 (7.14)	12 (7.14)	15 (8.92)	39 (23.2)	13 (7.7)	35 (20.8)
p value	0.009*	0.000*	0.000*	0.000*	0.325	0.000*
			Educational Status of Mother			
Illiterate	7(4.16)	10(5.95)	11(6.55)	10(5.95)	8(4.76)	10(5.95)
Primary school	1(0.59)	0	0	7(4.16)	0	7(4.16)
Higher school	8(4.76)	2(1.19)	11(6.55)	16(9.52)	15(8.92)	21(12.5)
Graduate	5(2.98)	5(2.97)	9(5.35)	9(5.35)	10(5.95)	6(3.57)
p value	0.833	0.026*	0.514	0.000*	0.292	0.000*
			Occupation of Mother			
Homemaker	21(12.5)	17(10.12)	30(17.85)	39(23.21)	30(17.85)	41(24.40)
Working	0	0	1(0.59)	3(1.78)	3(1.78)	3(1.78)
p value	0.080	0.228	0.128	0.410	0.767	0.286

*p-value <0.05 is statistically significant using Chi-square test

Table 3: Association of Sociodemographic variables with CIAF indices of undernutrition

Variables	No Failure	Wasting Only	Wasting and Under-weight	Wasting, Stunting and Under-weight	Stunting and Under-weight	Stunting Only	Underweight Only
			Age				
Less than 2 years	28 (16.6)	4 (2.38)	4 (2.38)	3 (1.72)	0	4 (2.38)	1 (0.5)
More than 2 years	38 (22.61)	16 (9.5)	35 (20.8)	16 (9.5)	11 (6.5)	5 (2.97)	4 (2.38)
p value	0.0001*	0.041	0.028	0.045	0.061	0.449	0.443
			Birth Weight				
< 2.5 kgs	17(10.12)	7(4.16)	27(16.07)	11(6.55)	5(2.98)	3(1.78)	1(0.59)
>2.5 kgs	49(29.16)	13(7.74)	12(7.14)	8(4.76)	6(3.57)	6(3.57)	4(2.38)
p value	0.001*	0.631	0.000*	0.217	1.000	0.735	0.398
			Birth Order				
1	4(2.38)	11(6.54)	13(7.74)	5(2.98)	0	2(1.19)	3(1.78)
2	23(13.69)	8(4.76)	25(14.88)	14(8.33)	10(5.95)	7(4.16)	2(1.19)
3	03 (1.78)	1(0.59)	1(0.59)	0	1(0.59)	0	0
p value	0.001*	0.461	0.283	0.139	0.009*	0.297	0.714
			Socio- economic Classification				
Middle Class	5(2.98)	0	1(0.59)	5(2.98)	1(0.59)	1(0.59)	0
Lower Middle Class	27(16.07)	5(2.98)	19(11.31)	7(4.16)	4(2.38)	6(3.57)	0
Lower Class	33(19.64)	15(8.92)	19(11.31)	7(4.16)	6(3.57)	2(1.19)	1(0.59)
p value	0.937	0.039	0.282	0.010*	0.919	0.240	0.216
			Gender				
Boys	41(24.4)	14(8.33)	22(13.09)	5(2.98)	6(3.57)	2(1.19)	1(0.59)
Girls	25(14.88)	6(3.57)	17(10.11)	14(8.33)	5(2.98)	7(4.16)	4(2.38)
p value	0.083	0.153	0.717	0.014*	1.000	0.083	0.184
			Feeding Practices During First 6 Months				
EBF	51(30.35)	19(11.31)	19(11.31)	16(9.52)	9(5.36)	5(2.98)	5(2.98)
Mixed BF	4(2.38)	1(0.59)	2(1.19)	3(1.78)	2(1.19)	1(0.59)	0
Formulae feed	11(6.54)	0	0	0	0	3(1.78)	0
p value	0.007	0.312	0.076	0.133	0.222	0.016*	0.624
			Complementary Feeding				
At 6 months	49(29.16)	12(7.14)	21(12.5)	9(5.35)	8(4.76)	5(2.98)	4(2.38)
6 – 12 months	17(10.11)	8(4.76)	18(10.71)	10(5.95)	3(1.78)	4(2.38)	1(0.59)
p value	0.032	0.805	0.183	0.133	0.748	0.725	0.654

Salter's Weighing machine was used to measure the weight of the child and measuring height measuring tape was used for children more than 2 years and was able to stand without support whereas for children below 2 years or height less than 85cms, the recumbent length was measured using infant meter.

The assessment of nutritional status was done by both conventional indices and CIAF. To evaluate the nutritional status of children, stunting (low height for age), underweight (low weight for height) and wasting (low weight for height) were used. The *Z-scores* for three *nutritional* indices like weight-for-age (WAZ), height-for-age (HAZ) and weight-for-height (WHZ) were calculated in reference to National Centre for Health Statistics standards for International reference population by *using* the *EPI*-NUT component of the EPI INFO software. The standard deviation of less than 2 can be considered undernutrition (Mohammadinia *et al.*, 2012).

To assess the children's nutrition status using CIAF Svedberg's model of the following six groups was used,

(1) stunted only,

(2) under-weight only,

(3) wasted only,

(4) wasting and underweight,

(5) stunted and under-weight and

(6) stunted, wasted and under-weight (Nandy and Miranda, 2008) in Table 1.

The data obtained was entered in the MS Office Excel sheet and statistical analysis was done using SPPS 21 version software. The descriptive statistics were expressed as frequencies, percentages. To ascertain the association between qualitative variables, chi-square tests were used and the standard deviation was used to depict scores. A p-value of <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

The study group consists of 168 under 5 children, 90 boys (53.57%) and 78 girls (46.43%). Most of them were in the age group of 4 to 5 years (52.38%). The majority of the informants were mothers (63.69&) and most of them were homemakers (87.5%). The rest of them was employed. A good number of them were literates (66.66%). While 49.40% of the study population belonged to socioeconomic class 5, 42.26% of them belonged to class 4 and 8.33% of them belonged to class 3.

The overall prevalence of stunting, underweight and wasting with the conventional measures are shown in Figure 1. But when measured with the indices of Composite Index of Anthropometric Failure, the prevalence of only stunting, underweight and wasting were 5.36%, 2.98% and 11.9%. This is because their combinations with other indices are included separately. Those combinations include wasting and underweight (23.21%), stunting and underweight (6.55%) and wasting, underweight and stunting (11.31%) (Figure 2). Prevalence of wasting was more than stunting which indicates that most of the children are suffering from acute nutrition-related problems.

Many children 31 (18.45%) with birth weight less than 2.5kgs had a Z score of W/A -3SD, i.e., severe underweight. Similarly, for children in the lower socio-economic class, 23 (13.6%) had Z scores of W/H -3SD, i.e., severe wasting and also an association of socio-demographic variables with conventional Z score indices are shown in Table 2.

As per CIAF, children more than 2 years 35(20.8%) were under category 3, i.e., wasting and underweight. Similarly, comparatively more girls 14(8.3%) were under category 4, i.e., wasting, stunting and underweight. Association of socio-demographic variables with indices of the Composite Index of Anthropometric Failure is shown in Table 3, Table 4.

Malnutrition is one of the most important health problems throughout the world in a large number of children in most of the developing countries (Victora *et al.*, 1986). Children in the preschool stage are highly vulnerable to malnutrition because they need more attention, as this is the period of rapid growth and development (Stokowski, 2005).

Investments made in the earlier years in children show a great effect in their long-term physical as well as mental health, earnings, social status and wellbeing. Stunting, underweight and wasting are used as anthropometric indicators of undernutrition in children. However, individually these three indicators cannot adequately express the overall number or prevalence of undernourished children in (Acharya *et al.*, 2013) a population, and they tend to conceal the real problem faced by the nation rather than reveal it.

Therefore, the newly constructed CIAF indicator (Nandy and Miranda, 2008) is a current improvement in evaluating childhood population nutritional status. It is a better tool to assess undernutrition than considering only stunting, wasting and underweight individually. The present study was undertaken to evaluate the levels of stunting, wasting, underweight and also to assess the overall prevalence of undernutrition by using CIAF.

Table 4: (Continued from Table 3) Association of Sociodemographic variables with CIAF indices of undernutrition

Variables	No Failure	Wasting Only	Wasting and Underweight	Wasting, Stunting and Underweight	Stunting and Underweight	Stunting Only	Underweight Only
No. of Illness Episodes in Last 6 Months							
Less than 2 episodes	66(39.2)	20(11.9)	9(5.35)	0	5(2.97)	9(5.35)	5(2.97)
More than 2 episodes	0	0	30(17.8)	19 (11.3)	6(3.57)	0	0
p value	0.000*	0.002*	0.000*	0.000*	0.279	0.220	0.309
Educational Status of Mother							
Illiterate	19(11.30)	6(3.57)	4(2.38)	8(4.76)	6(3.57)	3(1.78)	3(1.78)
Primary	0	0	6(3.57)	1(0.59)	0	0	0
Higher school	15(8.92)	12(7.14)	18(10.71)	17(10.11)	1(0.59)	3(1.78)	2(1.19)
Graduate	32(19.05)	2(1.19)	11(6.55)	3(1.78)	4(2.38)	3(1.78)	0
p value	0.001*	0.028	0.000*	0.358	0.153	0.929	0.303
Occupation of Mother							
Homemaker	51(30.36)	18(10.7)	35(20.83)	19(11.3)	11(6.54)	9(5.35)	5(2.98
Employed	15(8.92)	2(1.19)	4(2.38)	0	0	0	0
p value	0.003*	1.000	1.000	0.133	0.364	0.601	1.000
Utilization of Anganwadi Services							
Availed	19(11.30)	5(8.92)	21(12.5)	5(2.98)	8(4.76)	4(2.38)	0
Not Availed	47(27.98)	15(8.92)	18(10.71)	14(8.33)	3(1.78)	5(2.98)	5(2.98)
p value	0.139	0.327	0.013*	0.450	0.019*	0.725	0.160

*p-value <0.05 is statistically significant using Chi-square test

Signs of malnutrition were comparatively higher in females more than males, children who had more episodes of acute illnesses (ARI, ADD, etc.), children who were not provided with adequate supplementary/complimentary food or who were not breastfed during their first 6 months after birth, children with low birth weight, children with parents who had low educational status and children belonging to lower socio-economic classes. All the anthropometric measurements were correlated to various quantitative variables and it was found that socio-demographic variables and nutritional habits were significantly associated with the anthropometric measurements.

A comparison of prevalence of CIAF was made with previous studies and it showed that both the present study as well as the previous studies had reported higher rates of CIAF compared to the other three conventional measures of undernutrition (Biswas *et al.*, 2018). Thus, the total burden of malnutrition measured by CIAF in children less than five years of age is considerably higher.

Similar studies were conducted in various parts of India like West Bengal (Acharya *et al.*, 2013) and Karnataka (Anandi *et al.*, 2018) also yielded similar results.

The limitation in this study is that CIAF excludes children who are not in anthropometric failure and includes only those having stunting, underweight and wasting. The CIAF has been questioned because its indicators fail to describe the combination of stunting and obesity, which is an emerging problem of obesity among poor individuals (Composite index of anthropometric failure and geographic altitude in children from Jujuy (Bejarano *et al.*, 2014). Also, the study was conducted in a single semi-urban area of Tamil Nadu. Hence, the result cannot be generalized to the entire population of the country.

CONCLUSION

We can, therefore, conclude that by using the conventional measures of stunting, underweight, and wasting, we tend to underestimate the extent of

undernutrition. Hence, CIAF is a better indicator of anthropometric failure and is more certain.

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