ORIGINAL RESEARCH ARTICLE

Harnessing Poshan Tracker to Detect Composite Index of Anthropometric Failure Among 0-3 Year Olds in Rural Puducherry

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ABSTRACT

Background: Evidences suggest that the conventional indicators of malnutrition does not reflect the holistic burden of malnutrition. Hence, the utilization of Composite index of anthropometric failure (CIAF) for reporting malnutrition in Indian context was recommended. Our objective was to determine the proportion of children with CIAF and its association with age and sex in 0-3 years children from selected Anganwadis' of rural Puducherry.

Methods: This cross-sectional study using secondary data of 0-3 years was conducted across the 25 Anganwadis' of our rural field practice area during July 2024. All children of 0-3 years whose length (<2 years)/height (≥2 years), weight and date of birth information were available in the Poshan Tracker were included in the study. The interpretation of their nutritional status was obtained from the Poshan Tracker. WHO Anthro Survey analyser and R software was used for further analysis.

Results: Of the 829 children**,** proportion of children with CIAF was 281(33.8%). There was a significant difference in proportion of anthropometric failure between girls with 28% and boys with 41% (P <0.001). As per CIAF stages (N=281), stunting was the predominant form of malnutrition in 19% followed by stunting and underweight in 6% and wasting in 3.6%. The prevalence of anthropometric failure was higher in children between 1-2 years and among boys.

Interpretation and Conclusions: One in three children of 0-3 years age group had anthropometric failure with more prevalence among children less than two years and boys. Longitudinal follow up of these children along with exploration of their dietary intake might provide insights for targeted interventions. The cross-sectional nature of this study limits causality inference.

Keywords: Anthropometry, Analysis, Secondary data, Composite Index of Anthropometric Failure, Poshan Tracker, Population, Rural, Malnutrition

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Introduction

Globally, nearly half of all deaths in under five children were attributed to undernutrition.[1] Malnutrition among under five children is a significant public health problem in India.[2] The nutritional status of infants and children are classified by WHO using the anthropometric measures such as: underweight, wasting, stunting, overweight and obesity Z scores.[3] The prevalence of overall stunting, wasting, underweight and overweight indicators among under five children from rural areas of India was 37.3%, 19.5%,33.8% and 3.2%.[4] While in rural Puducherry, the burden corresponds to 15.6%, 12.9%, 13.7% and 6.5% respectively.

The burden of stunting and overweight were comparatively high in rural areas as compared to the urban areas of Puducherry.[4] However, studies suggest that these nutritional indicators do not represent the holistic burden of malnutrition as combinations of malnutrition can co-exist in the same child.[5,6] Composite index of anthropometric failure (CIAF) captures simultaneous failures in height-for-age, weight-for-height, and weight-for-age, providing a single holistic measure. The initial Svedberg model of CIAF included 7 categories (A-Y) which was later expanded by Kuiti and Bose et al to include two more categories (Operational definitions).[5] Considering the growing burden of overweight and obesity in rural areas, Indian Academy of Pediatrics (IAP) has proposed the extended composite index of anthropometric failure (CIAF) as a screening tool in community (Operational definition).[7]

CIAF has been defined as one minus the proportion of children with no failure in any form.[8] The research gap persists as Indian studies have not explored this context in rural setting unlike urban and tribal setting in the under five children.[9] The rationale of studying in 0-3 years group being, the first 1000 days of life from conception till the child's second birthday is crucial for the child's growth. The anecdotal evidence suggests the uniform availability of this information in all the Anganwadis' through the launch of Poshan Tracker application in 2021 by Government of India. The latter is provided with the features of growth measurement, tracking of services, home visit alerts, real time recording and monitoring and pre-school education. The final nutritional status of each child is directly computed against the given indices of stunting, wasting and underweight, following the anthropometric data entry using this application.[10] Hence, this study was proposed to address the dearth of information about anthropometric failure in rural setting using secondary data from Poshan Tracker.

Our study is among the first studies using Poshan Tracker data for CIAF in rural 0-3-year-olds. The primary objective being to estimate the proportion of CIAF using IAP recommended extended CIAF classification. Secondly, to predict CIAF using age group and sex variables.

Methodology

General Setting: About 855 Anganwadis' are operational in all the four districts of Union Territory of Puducherry as of 2021 (Puducherry, Karaikal, Yanam and Mahe).[11] This study was conducted in Puducherry District (population ~1 million), a coastal plain area in South India. There are four project areas of ICDS in Puducherry District in which our project area comprised a total of 173 Anganwadis'.

Poshan Tracker application: The growth monitoring of under five children is routinely done by AWWs at the AWCs where weight and height measurements were recorded on a monthly basis. The details were entered in register followed by Poshan Tracker application by the AWWs for which they had received training. Interpretation of nutritional status in Poshan Tracker as Z scores is based on WHO 2006 growth standards. Those children identified as severe acute malnutrition (SAM) were referred to tertiary care public hospital by the AWWs for further assessment and admission at a case-to-case basis.

Specific study setting and study design: This cross-sectional survey included 0-3 years children from all the twenty-five Anganwadis' surrounding the field practice area of our tertiary teaching private institute in rural Puducherry considering the operational feasibility. The population of our service area accounts to 36,746 with about 2573 children in under five age group.

The study participants included 0-3 years children whose secondary data on length, height, weight and date of information for the month of July 2024 were available. Study from an urban setting of similar union territory Delhi, India revealed the burden as 45% in under five age group.[2] Considering the arbitrary prevalence of anthropometric failure of 40% as a reference (due to dearth of information in 0-3 years in a rural setting), the sample size was estimated using Open Epi software.[12] The absolute precision was taken as 4% with a Z value of 1.96 and design effect of 2, which yielded a sample size of 1152 at a 95% confidence interval.

Data collection method and tool: Administrative permission from the respective Central Development Program officer and Integrated Child Development services in charge was obtained prior to the conduct of this study. Also, the waiver of written informed consent to collect the secondary data was obtained from the Institutional Human Ethics committee. A micro plan was designed by the Principal Investigator where a team of two co-investigators were assigned to visit two Anganwadis' per week between July 2024 and September 2024 in order to cover all the 25 AWCs. The secondary data of each child was obtained for the following indices of stunting, wasting and underweight from the Poshan Tracker application provided to the Anganwadi workers as of July 2024. The data entry in the field was done in a register comprising of the information about unique ID of

the child, including their age, gender, length/height, weight, date of birth, date of reporting, interpretation of the indices. There was no missing data observed from the application related to the indicators. Later, it was entered in the Microsoft excel 2016 by the co-investigators and were checked for outliers and double entries.

Statistical Analysis: The record-based data entered in the Microsoft Excel was cleaned, coded, and analyzed using the WHO Anthro Survey Analyzer version 3.2.2 and R software version 4.3.1. The dependent variable was CIAF where the prevalence was considered as proportion with 95% confidence interval. The continuous variables were summarized as median (IQR) and categorical variables such as age groups and gender were summarized as number (%). Pearson's chi-square test of significance was used to study the relationship between dependent and independent variables. To avoid overestimating the risk using odds ratio for a commonly prevalent condition such as CIAF, it was preferred to present the results as prevalence ratio using log binomial regression.[13] Multivariable regression was applied to identify the predictors of CIAF after adjusting for the confounders and its corresponding adjusted prevalence ratio was reported. Data visualization was done using density plot and horizontal clustered bar chart. P-value less than 0.05 was considered significant.

Ethical considerations: The administrative permission was obtained from the State level ICDS and CDPO in charge as 2843/DWCD/ICDS Cell/Misc./2024-25 dated 21/6/2024. The ethics permission of waiver for informed consent (as study involved secondary data) was obtained from the Institutional Human Ethics Committee SMVMCH-ECO/AL/326/2024 dated 15/7/2024 as per National Ethical guidelines for Biomedical and Health research involving human participants norms.

Operational Definitions:

Indicators[3]

Underweight - weight for age less than -2 SD
Wasting - weight for length/height less than -2SD
Stunting - length/height for age less than -2 SD
Overweight - BMI for age > +2SD
Obesity - BMI for age >+3SD Z scores

Table 1: Extended CIAF classification[7]

A	No failure
B	Wasting only
C	Wasting and Underweight
D	Wasting, stunting and underweight
E	Stunting and underweight
F	Stunting only
Y	Underweight only
G	Stunting and overweight
H	Overweight only

CIAF = 1-A / (A + B + C + D + E + F + Y + G +H)

RESULTS

Overall, our study included 829 participants of 0-3 years age group from 25 AWCs. The median (IQR) age of participants from these AWCs were 19(10,27) months with 435(52.5%) being girls and 394(47.5%) boys. Figure 1 shows the density plot with Z scores in X axis for L/H age, W/L or H for age, weight for age and BMI for age (continuous lines). Skewness towards left was observed across all age groups in L/H for age and up to 12-23 months in W/A indices. Such left-skewed distributions indicate higher prevalence of low Z-scores. Also, the distribution curve was kurtotic for L/H for age throughout all age groups. Similarly, skewness and kurtosis were also observed towards left for both the sex in L/H for age as given in Supplementary Figure 1.

The overall burden of stunting, wasting, overweight and underweight according to conventional indices in our study were 28.5%, 4.5%, 2.8% and 8.2% and respectively. While the burden of severe stunting and severe wasting was 18.3% and 1.2%. Figure 2 shows the age wise and gender wise prevalence of conventional indices of overall stunting, wasting, severe wasting, overweight and underweight as reported in surveys. X axis comprises of proportion (%) and Y axis comprises of various categories of age groups and gender. The vertical dotted line indicates the average and the dot presents the burden of indicator with 95% CI as horizontal line.

Table 1 given below depicts the categories of CIAF from the secondary data of 829 children of 0-3 years children by sex. The most common malnutrition category prevalent was only stunting in 156(19%) children followed by stunting and underweight in 50(6%) and only wasting in 30(3.6%). New categories of stunting and obesity found in 7(0.8%) and stunting, underweight and overweight prevalent in 2(0.2%) were found.

The overall burden of CIAF in children up to three years (N=829) was 281(33.8%) with 95% CI (31%, 37%) while in children up to two years (N=555) was 212(38.2%) with 95% CI (34.2%,42.3%). Further, stratification by age group found the prevalence of CIAF in 13-24 months (N=294) to be 104(35.4%) with 95% CI (30%,41%) and in 25-36 months (N=274) was 69(25.2%) with 95% CI (20.3%, 30.6%).

There was a significant difference in proportion of CIAF in 0-3 years girls with an estimate of 121(28%); 95% CI (24,32) and boys were 160(41%); 95% CI (36,46) by Chi square test (P <0.001). The age wise categorisation of CIAF is given in Figure 3. Amongst the categories of CIAF, stunting and underweight was common up to 6 months age group followed by stunting in both 7-24 months and 25-36 months thereby reflecting an overall chronic malnutrition pattern.

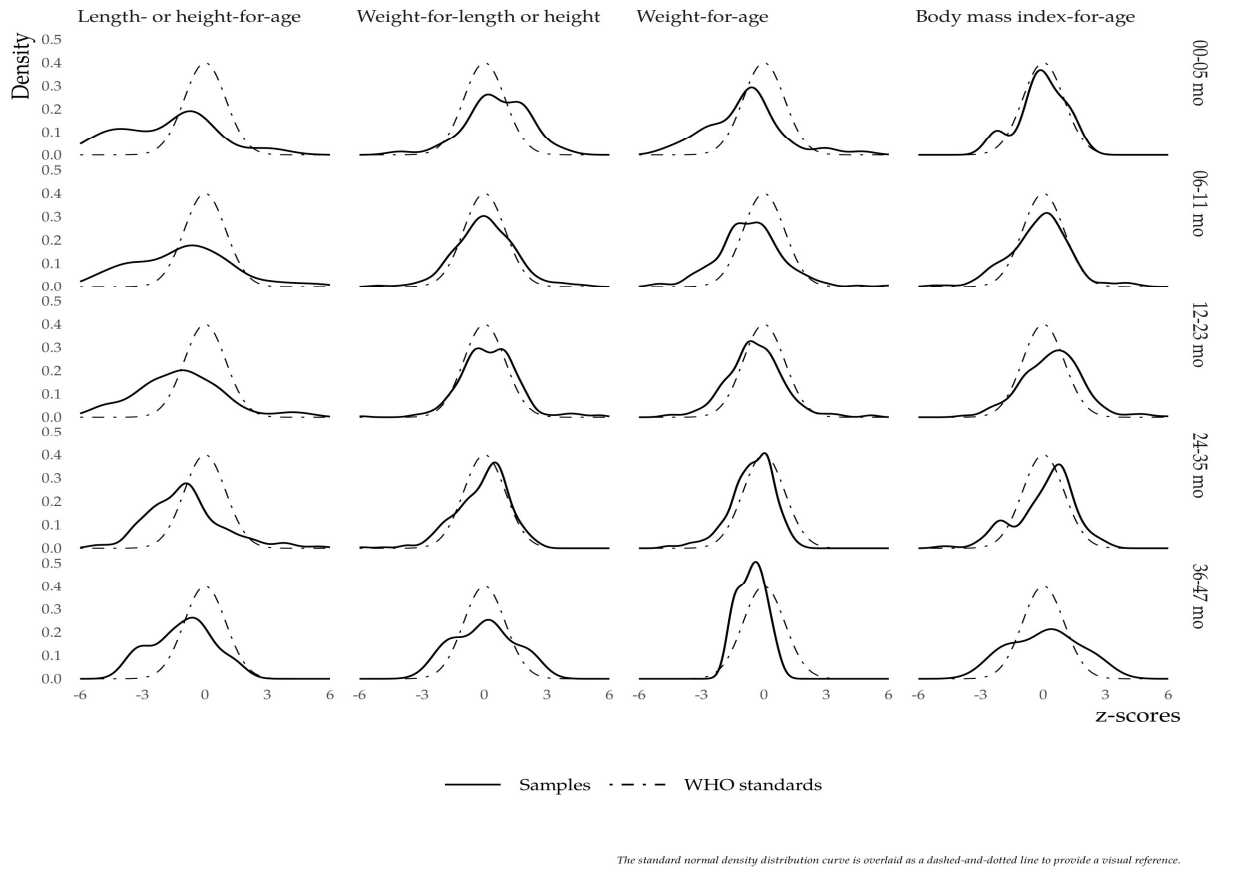

Figure 1: Density plot of length/height and weight in 0-3 years children from selected Anganwadis' during July 2024-September 2024 in Puducherry district, India by age groups (N=829)

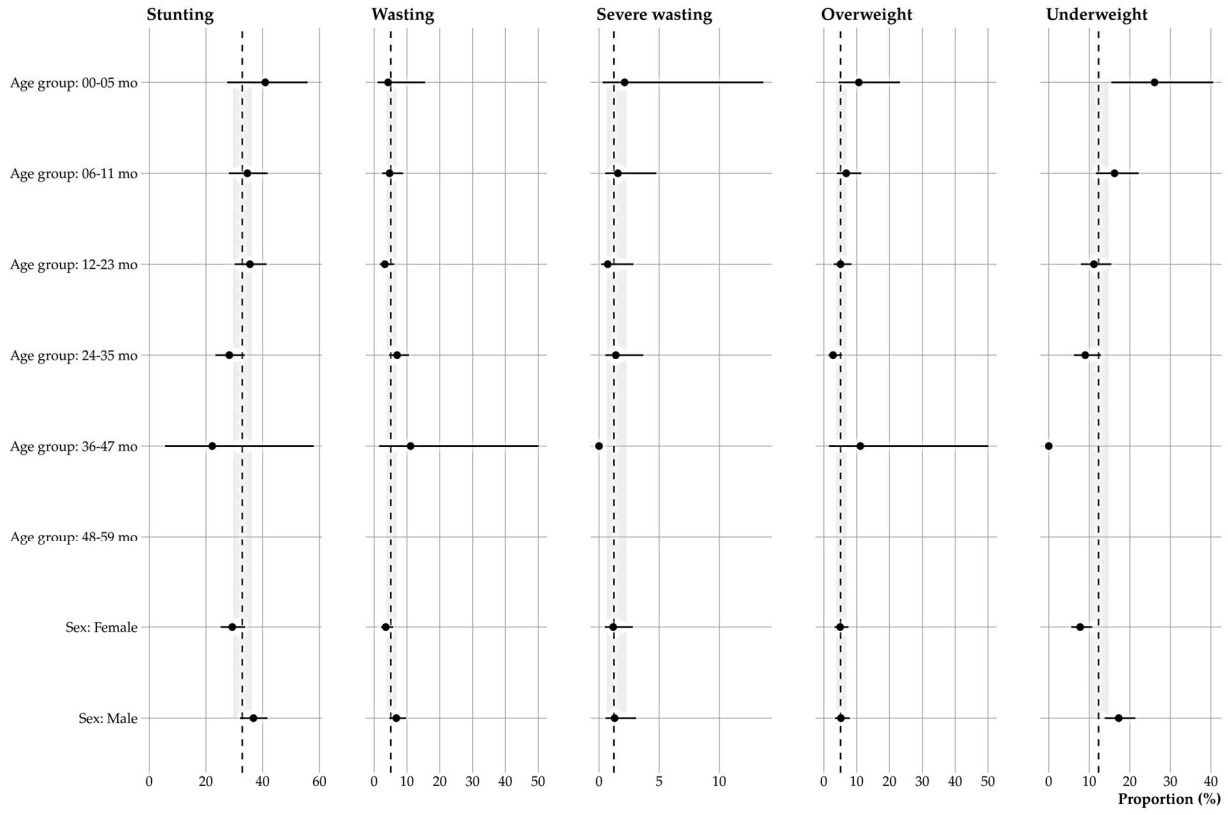

Figure 2: Burden of conventional indices of malnutrition in 0-3 years children from selected Anganwadis' between July 2024 and September 2024 in Puducherry, India by age group and sex.

Table 2: Composite Index of Anthropometric failure in 0-3 years children from selected Anganwadis' between July 2024 and September 2024 in Puducherry, India by sex (N=829)

Characteristic	Total (N=829)[1]	95 CI[2]	Female (N=435)[1]	95 CI[2]	Male (n=394)[1]	95 CI[2]
Normal	548 (66)	63, 69	314 (72)	68, 76	234 (59)	54, 64
Wasting only	30 (3.6)	2.5, 5.2	8 (1.8)	0.86, 3.7	22 (5.6)	3.6, 8.5
Wasting and Underweight	4 (0.5)	0.15, 1.3	1 (0.2)	0.01, 1.5	3 (0.8)	0.20, 2.4
Wasting, stunting and underweight	4 (0.5)	0.15, 1.3	0 (0)	0.00, 1.1	4 (1.0)	0.33, 2.8
Stunting and underweight	50 (6.0)	4.6, 7.9	17 (3.9)	2.4, 6.3	33 (8.4)	5.9, 12
Stunting only	156 (19)	16, 22	79 (18)	15, 22	77 (20)	16, 24
Underweight only	8 (1.0)	0.45, 2.0	1 (0.2)	0.01, 1.5	7 (1.8)	0.78, 3.8
Stunting and overweight	17 (2.1)	1.2, 3.3	9 (2.1)	1.0, 4.0	8 (2.0)	0.95, 4.1
Overweight only	3 (0.4)	0.09, 1.1	2 (0.5)	0.08, 1.8	1 (0.3)	0.01, 1.6
Stunting and Obesity	7 (0.8)	0.37, 1.8	3 (0.7)	0.18, 2.2	4 (1.0)	0.33, 2.8
Stunting, underweight and overweight	2 (0.2)	0.04, 0.97	1 (0.2)	0.01, 1.5	1 (0.3)	0.01, 1.6

[1]n (%),[2]CI = Confidence Interval

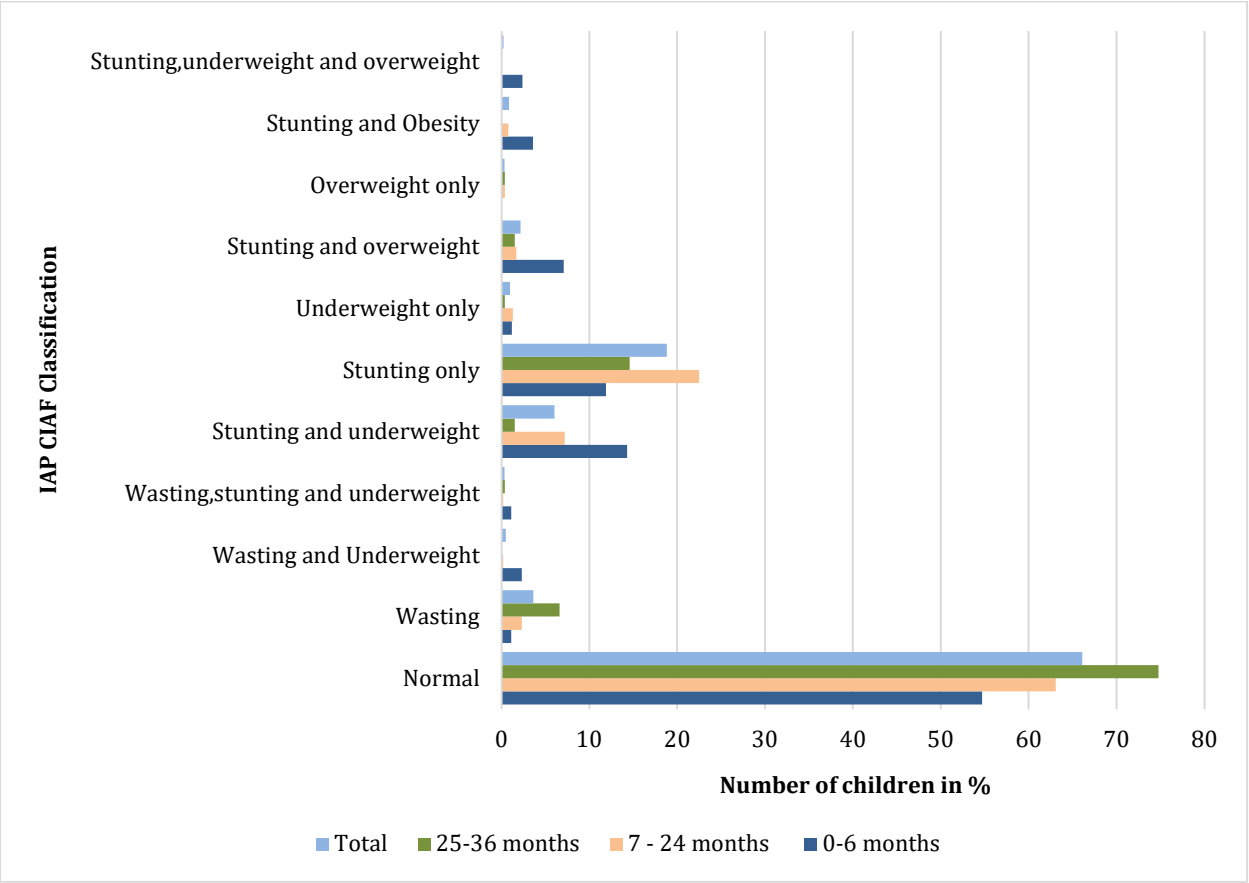

Figure 3: Bar chart depicting CIAF classification in 0-3 years children from selected Anganwadis' between July 2024 and September 2024 in Puducherry district, India by age groups (N=829)

We fitted a log binomial mixed model that seems to be a good fit with low collinearity (variance inflation factor less than 2), with residuals lying along the diagonal line (Q-Q plot) and the predicted intervals overlap well with the observed (posterior predictive check) (Supplementary Figure 2). The model included AWWs as random effect and the intra class correlation was 27%. The accuracy of this mixed model was 62%. The baseline intercept of CIAF was 0.20 (exponentiated coefficient) for girls and children less than 12 months. It was found that children belonging to birth to 12 months (aPR: 1.66, 95%CI 1.07,2.59, P 0.025); and boys (aPR: 1.48, 95%CI 1.19,1.84, P <0.001) had higher prevalence of anthropometric failure compared to those beyond 2 years of age and girls.

There were seven Anganwadis' identified as high focus with the prevalence of anthropometric failure beyond 50% as displayed in the Supplementary Table 2.

Discussion

In our study, it was observed that three in ten children of 0-3 years had anthropometric failure. The ra-

tionale of limiting the study to this age group being uniform availability of information across all the Anganwadis' as older children (beyond three years of age) tend to attend play schools. Although CIAF was documented globally, there is a dearth of information in 0-3 years group thereby limiting the region wise comparison.[6,14] However, study in toddlers between 13-36 months at Chhattisgarh, India found the burden of CIAF to be 62.1% which is twice the burden of our current study i.e., 30.5%.[15] Similarly, the burden of CIAF in children less than two years in our study was 38% which is less than 48% reported from the secondary data analysis of NFHS-5 in the same age group.[16]

The overall burden of stunting, underweight and wasting according to conventional indices in our study were 28.5%, 8.2% and 4.5% respectively. These findings were less than 13.7% and 12% of underweight and wasting reported by NFHS 5 (2020-2021) survey in rural Puducherry.[4] The higher burden in conventional indices when compared to CIAF in our study was because of the overlap between the three indices i.e. a child who is stunted might present with stunting and underweight or other forms. Therefore, these three indices cannot determine the comprehensive burden of malnutrition in the community unlike CIAF. A Lancet study has found that Poshan tracker application often estimates lower burden of undernutrition as compared to the NFHS 5 data.[17] The discrepancy may be due to differences in timeline, where the NFHS-5 captured the data between 2019-2021 and that of Poshan Tracker from 2021. Secondly, the training of data collectors and instruments used in the measurements differ between the both. This gap may be bridged with the further rounds of NFHS, which will overlap with the data of Poshan Tracker archived thereby facilitating accurate comparisons.[17]

The most common form of anthropometric failure in our study being stunting in 19% children followed by stunting and underweight in 6% and only wasting in 3.6%. These findings were comparable with the findings of Goyal M et al[2] where stunting was the commonest form of malnutrition. In addition to the nine categories, there were two new categories of stunting, underweight and overweight in 0.8% and stunting and obesity in 0.2 % of the population. The former new category was also reported in a study by Nandeep ER at al where biological plausibility of underweight and overweight to co-exist in a child with stunting was further explained.[5]

It was found in our study that the proportion of anthropometric failure was more likely in boys as compared to girls in 0-3 years group. The reversal pattern was documented in studies involving under five children by Jeyakumar A et al.[9] Both biological and social mechanisms were proposed to be responsible for the difference between boys and girls.[18] Studies have shown attribution of undernutrition to greater calorie need and physical activity in boys as compared to girls.[6] The other finding of our study was increased likelihood of anthropometric failure in children of birth to 12 months which were also observed from Indian and Ethiopian studies.[2,14] As children beyond 6 months age are more vulnerable than toddlers and preschool children due to increased nutritive demands, poor feeding and weaning practices and risk of infection.[14]

Our study was conducted in routine programmatic setting of all the Anganwadis' within our rural field practice area. Also, the classification was extended beyond the nine level of CIAF classification to include children with other presentations such as stunting and obesity; and stunting, underweight and overweight. This is concordance with the NFHS 5 findings of rural Puducherry where there was slightly higher prevalence of overweight and stunting. These findings require further study and validation of the burden in a large sample size along with the capture of primary information pertaining to maternal and feeding practices.

Further, we planned to longitudinally follow up the seven high focus Anganwadis' identified and reported to program managers considering the operational feasibility. We intend to obtain the primary information pertaining to maternal, child feeding practices and micronutrient deficiencies of children identified with anthropometric failure for planning targeted interventions. The strength of the study lies in the use of real-time application for demonstration of CIAF calculation for further monitoring and policy relevance. The observed prevalence of CIAF (33%) with narrow precision (31%,37%) was within the arbitrary range (40 ± 4%) considered for sample size calculation, thereby adding to the accuracy. The major limitation underlies with the use of secondary data and data entry error where the quality of data is questionable and subjected to measurement bias by the Anganwadi workers to a certain extent. Also, the study lacks information about the potential confounders like socio-economic status, education status of the mother etc., Secondly, the findings of the study cannot be generalized outside the study settings to all children of 0-3 years age group due to methodological limitations.

Conclusion

Through routinely used Poshan Tracker application, co-existing forms of undernutrition and overnutrition were studied. One in every three children present with anthropometric failure. Children less than 2 years and boys were more likely to present with anthropometric failure in our study. Cohort studies in children where the tracking of CIAF at various intervals along with exploration of maternal, feeding and dietary intake might provide understanding of the changes in the growth pattern of children. This will also serve as a basis for proposing targeted interventions to children and studying the post intervention effect.

Recommendations and implications for policy change

CIAF can be derived from the real time data available within the Poshan Tracker application without much efforts for identifying areas that demand programmatic action. Reliance on the anthropometric data, necessitates strengthening of the supportive supervision and random verification of the measurements to improve the data validation. Further, education to mothers of children at earlier period may be emphasized through the available features of Poshan Tracker application to prevent the onset/progress of anthropometric failure.

Supplementary File

Supplementary Figure I: Density plot of length/ height and weight in 0-3 years children from selected Anganwadis' between July 2024 and September 2024 in Puducherry district, India by sex (N=829)

Supplementary Figure II: Model diagnostics of log binomial regression for identifying the predictors of CIAF in 0-3 years children from selected Anganwadis' between July 2024 and September 2024 in Puducherry district, India

Supplementary Table I: Heat matrix of high focus AWW's based on the CIAF burden in 0-3 years children between July 2024 and September 2024 in Puducherry district, India (N=25)

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Individual Authors' Contributions: Concepts: RG: Concept, design, literature search, data collection, data/statistical analysis, manuscript drafting and review. **RM**: Design, intellectual content, data/ statistical analysis, manuscript review. **SS**: Literature search, data collection, data analysis, manuscript drafting and review. **PK**: Design, manuscript review, guarantor of the study.

Availability of Data: Will be shared upon the request to the corresponding author following permission from the ICDS wing.

Declaration of No use of generative AI tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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