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PREVALENCE OF MALNUTRITION IN SCHOOL-GOING CHILDREN WITH SPECIAL REFERENCE TO *STHAULYA* AND *KARSHYA*: A CROSS-SECTIONAL SURVEY STUDY

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ABSTRACT:

Introduction: Malnutrition implies both extremes of impaired nutrition; under-nutrition and over-nutrition. The state of *Karshya* (emaciation)*/Atikarshya* (excessive emaciation), *Sthaulya* (obesity)/*Atisthaulya* (excessive obesity) described in Ayurveda represent both aspects of malnutrition. Reliance on qualitative observations and insouciance to anthropometric indices makes it challenging and arduous to assess malnutrition with an Ayurveda perspective in research studies. This study aimed to ascertain prevalence of malnutrition in school-going children using Ayurvedic parameters of malnutrition with special reference to *Sthaulya*, *Karshya* and assess compatibility of these parameters to anthropometric indices for assessing malnutrition. **Methods:** A cross-sectional survey study involving 1001 students in 6-16 years age group from 10 urban, rural schools in Sushrutha Ayurvedic Medical College & Hospital was carried out. After obtaining ethical clearance, parental consent and participants' assent, anthropometric measurements of students were taken and presence of signs, symptoms of *Sthaulya*, *Karshya* was noted. All data were analysed in Microsoft Excel.

Results: Based on Ayurvedic parameters a very high prevalence of malnourishment (51%) with 112 (11.18%) children in *Sthaulya*, an exorbitant number of 399 (39.86%) children falling under *Karshya* category was observed.

Conclusion: Symptoms of *Sthaulya*, *Karshya* described in Ayurveda are a good measure to screen and assess malnourished children. A fair correlation was observed between symptoms of *Sthaulya/Karshya* and anthropometric measurements was noted. Ayurvedic parameters were more sensitive than BMI in recognising children at borderline undernutrition while they failed to record overweight, marginally obese children.

Keywords: Anthropometric measurements, Children, Emaciation, Obesity, Underweight

INTRODUCTION:

Karshya (emaciation), *Sthaulya* (obesity) in paediatric population are indicators of childhood malnutrition. *Karshya* is reduction in *Upachaya* (body mass), *Mamsa* (muscle), *Bala* (strength) and *Sthaulya* is a condition of excess *Meda* (adipose tissue).[1] Anthropometric measurements being simple, non-invasive techniques are especially suited to assess malnutrition for survey studies. However, they are insufficient to record recent onset malnutrition, differentiate fat and lean muscle mass, locate fat deposit or loss, or impingement by oedematous fluid.[2,3] Likewise, *Mamsa Sara* (predominance of muscles) or *Asthi Sara* (predominance of bones) person may fall in overweight BMI range despite normal amount of fat in body.

Ayurveda does not rely on anthropometric measurements to assess malnutrition but on the presence of subjective and objective symptoms of *Sthaulya* and *Karshya*. There is a need to authenticate these sign and symptoms to define a new integrative approach, considering limitations of anthropometric indices to assess malnutrition.[4,5]

OBJECTIVES:

The primary objective of this study was to ascertain prevalence of malnutrition using Ayurvedic parameters with special reference to *Sthaulya*/*Karshya* in school-going children. Secondary objective was to assess feasibility of this new approach to assess malnutrition, check compatibility of anthropometric measurements with objective parameters of *Sthaulya*/*Karshya*.

MATERIALS AND METHODS:

Subjects: Among twenty-five schools, randomly selected from urban and rural areas, ten schools (4 urban, 6 rural) permitted to carry out the study. Children aged 6-16, regardless of gender, religion, ethnicity were enrolled and children with systemic disease-induced malnutrition were excluded. Strict COVID protocol including protective gear and sanitization were followed during data collection.

Ethical Considerations: The Institutional Ethics Committee's approval for study was obtained (letter number RES/SAMC & H-IEC/07/2021) before commencement of the study. Informed consent was taken from parents/legal guardians on a bilingual (English/Kannada) consent form. For subjects more than 12 years, assent was taken on a bilingual assent form. Identity of subjects, data collected was kept confidential.

Sample Size: The initial sample size of 384 subjects was determined based on a single proportion population formula using formula n= $Z^2 \times P \times q / d^2$

n= required sample size

Z- Standard normal deviate; 1.96 (corresponding for 95% confidence interval)

p- Proportion in population possessing characteristic of interest. Taken a prevalence of malnutrition of 50% (i. e. .5) based on previous study. [6]

q = (1-p) Proportion in target population not having characteristic of interest (1-.5=.5)

d- Margin of error at 5% (standard value of 0.05)

The survey utilized a single-stage cluster sample design, representing a selection of schools. To adjust for this design variation, the sample size was multiplied by the design effect (D), typically assumed to be 2 for nutritional surveys with cluster sampling. A 20% non-response rate due to the ongoing COVID-19 pandemic was factored in. Thus, the final required sample size was calculated as 960 participants (dividing the sample size by the response rate of 80% and multiplying by 100). Ultimately, 1001 subjects were recruited for the study.

Data Collection: The data collection started on 29-11-2021 and was completed on 25-04-2022. Demographic data for gender, age, grade, socio-economic status, religion and family composition was taken. Heart rate, blood pressure, and respiratory rate were checked.

Anthropometric measurements of all participants were recorded. To minimize observers' bias same team of observers collected data in all the schools after getting trained in standard protocol for taking anthropometric measurements. The body weight in light clothing to the nearest 0.1 kg with a calibrated mechanical scale, height to the nearest 0.1 cm. by wall mount height measure while subjects standing barefoot on the flat surface with heels facing forward, and head, buttocks and heels touching the wall was measured. Abdominal circumference (AC) at the level of the umbilicus, hip circumference (HC) across the widest portion of the buttocks at the level of the greatest posterior protuberance, waist circumference (WC) at the midpoint of the lowest point of the rib cage and the iliac crest, in a standing position at the end of the expiration, using non-stretchable tape to the nearest 0.1 cm and mid upper arm circumference (MUAC) at the midpoint between the shoulder tip and the elbow tip on the left arm with arms hanging freely were measured.

Criteria for diagnosis:

Based on signs and symptoms of *Karshya/Atikarshya*, *Sthaulya/Atisthaulya* described in Ayurveda, twelve signs and symptoms relevant to the paediatric age group were selected for diagnosing both the conditions.[7,8] [Table 1]

Table 1: Diagnostic symptoms of *Sthaulya* and *Karshya*

***Karshya* Symptoms**		***Sthaulya* Symptoms**	
Objective	**Subjective**	**Objective**	**Subjective**
Twagasthi shesha (bony and skinny)	*Pipasa Asahishnuta* (unable to tolerate thirst)	*Ativriddha Meda* (gross obesity)	*Ati Pipasa* (excessive thirst)
Shushka Sphik (emaciated hips)	*Kshut Asahishnuta* (unable to tolerate hunger)	*Chala Sphik* (pendulous buttocks)	*Ati Kshut* (excessive hunger)
Shushka Udara (scaphoid abdomen)	*Sheeta Ushna Asahishnuta* (unable to	*Chala Udara* (pendulous abdomen)	*Atinidra* (excessive sleep)

	tolerate cold/heat)		
Shushka Greeva (thin neck)	*Alpa Prana* (~lack of energy)	*Chala Stana* (pendulous breast/chest)	*Alpa Prana* (lack of energy)
Sthoola Parva (prominent joints)	*Ayasa Asamrthata* (exercise intolerance)	*Kshudra Swasha* (shortness of breath)	*Ayasa Asamrthata* (exercise intolerance)
Dhamani Jala Santata (visible veins)	*Aruchi* (lack of interest in food)	*Gatra Daurgandhya* (body smell)	*Ati Sweda* (excessive sweating)

Children were examined for the presence of objective symptoms and interviewed for the presence of subjective symptoms of *Sthaulya* and *Karshya* and were graded in three categories based on the number of symptoms present; 1-4 symptoms as *Hina* (low), 5-8 symptoms as *Madhya* (middle), and 9-12 symptoms as *Adhika* (high) grade of *Sthaulya/Karshya*.

Criteria for diagnosing symptoms like *Twagasthi Shesha* (bone and skin appearance) , *Ativriddha Meda* (gross obesity), *Chala Udara* (pendulous abdomen), *Shushka Udara* (scaphoid abdomen), *Shushka Greeva* (thin neck) and *Shushka Sphik* (emaciated hips) were fixed and the images of malnourished children with these symptoms were shown to the observers for affirming the diagnosis until all the observers consistently produced similar observations for every image in training sessions.

Age and gender-appropriate BMI values from revised growth reference charts for BMI (body mass index) by Indian Academy of Paediatrics (IAP) were taken for categorizing 1001 children into underweight, overweight, obese and normal.[9]

Data Analysis: Collected data were entered and analysed in Microsoft Excel (Microsoft Excel. Redmond, Washington, USA). Descriptive statistics are presented as counts and per cents (%) for categorical variables and as means and standard deviations (SD) for continuous variables. Bivariate correlation analyses were performed to assess the relationship between discrete variables (number of *Sthaulya/Karshya* symptoms present) and BMI as the dependent variable.

RESULTS:

Out of 1001 students, the majority (734) were in grade 5 and above. Among them, 480 were girls and 521 were boys. 482 students belonged to rural areas, and 519 were from urban areas. About 94% followed the Hindu religion. Only 13% were pure vegetarians, while the rest had a mixed diet. Most children (65.2%) belonged to the middle-income group, with 32.4% in the low-income group and 2.4% in the high-income group based on the modified Kuppuswamy socioeconomic scale for 2021. There were 96 single children, while 61% had one sibling, and approximately 24% had two siblings. Sixty-one students had three or more siblings.

Among the symptoms of *Karshya*, *Sheeta Ushna Asahishnuta* (intolerance to cold and heat) was the most common feature followed by *Pipasa Asahishnuta* (intolerance to thirst) and *Kshut Asahishnuta* (intolerance to hunger). Symptoms like *Sthoola Parva* (prominent joints) and *Dhamani Jala Santata* (visible veins) were present in only 5% of the students. Among the symptoms of *Sthaulya Ati Pipasa* (excessive thirst) and *Ati Sweda* (excessive sweat) were the most common features. Around 10% of students had a pendulous belly, chest and buttocks indicating gross obesity with symptoms like *Chala Udara* (11%), *Chala Stana* (9%) and *Chala Sphik* (10%). [Table-2]

[Table 2] Frequency of Symptoms of *Karshya* and *Sthaulya* in all subjects

Karshya			***Sthaulya***		
Symptom	**Present (%)**	**Not Present (%)**	**Symptom**	**Present (%)**	**Not Present (%)**
Twagasthi Shesha	366 (37%)	635 (63%)	*Ativriddha Meda*	87 (9 %)	914 (91%)
Shushka Sphik	382 (38%)	619 (62%)	*Chala Sphik*	96 (10 %)	905 (90 %)
Shushka Udara	386 (39%)	615 (61%)	*Chala Udara*	107 (11%)	894 (89%)
Shushka Greeva	374 (37%)	627 (63%)	*Chala Stana*	94 (9%)	907 (91%)
Sthoola Parva	50 (5%)	951 (95%)	*Kshudra Shwasa*	71 (7%)	930 (93%)
Dhamani Jala Santata	50 (5%)	951 (95%)	*Ati Pipasa*	357 (36%)	644 (64%)
Kshut Asahishnuta	435 (43%)	566 (57%)	*Ati Kshut*	231 (23%)	770 (77%)
Pipasa Asahishnuta	467 (47%)	534 (53%)	*Ati Sweda*	326 (33%)	675 (67%)

Sheeta Ushna Asahishnuta	515 (51%)	486 (49%)	*Gatra Daurgandhya*	249 (25%)	752 (75%)
Aruchi	46 (4.6%)	955 (95.4%)	*Atinidra*	284 (28%)	716 (72%)
Alpa Prana	241 (24%)	760 (76%)	*Alpa Prana*	18 (1.8%)	983 (89.2%)
Ayasa Asamarthata	45 (4.5%)	956 (95.5%)	*Ayasa Asamarthata*	24 (2.4%)	977 (97.6%)

The mean values of corresponding anthropometric values of various objective symptoms of *Sthaulya* and *Karshya* in affected and normal children are presented in table no. 3.

Table 3: Objective symptoms and Mean Anthropometric Measurements in affected and normal children

Symptom	No of affected children	Corresponding anthropometric measurement	Mean in affected children	Overall Mean (*n*=1001)
Ativriddha Meda	88	BMI (Kg/m2)	26.32 Kg/m2 SD ±4.206 Kg/m2 SE ± 0.4484 Kg/m2	17.62 Kg/m2 SD ±4.214 Kg/m2 SE ±0.1332 Kg/m2
		Body weight	61.45 Kg/m2 SD ±13.209 kg SE ±1.416 kg	38.35 kg SD ±14.135 Kg SE ±0.4468 Kg
		MUAC	27.54 cm SD ±3.38 cm SE ± 0.360cm	21.35 cm SD ±3.801 cm SE ±0.120 cm
Chala Udara	108	Abdominal Circumference	84.69 cm SD ± 9.741 cm SE ±0.9373 cm	66.51 cm SD ±11.560 cm SE ±0.3654 cm
		BMI	25.51 Kg/m2 SD ±9.7411 Kg/m2 SE ± 0.4140 Kg/m2	17.62 Kg/m2 SD ±4.214 Kg/m2 SE ±0.1332 Kg/m2
Chala Sphik	49	Hip Circumference	94.430 cm SD ±10.27 cm SE ±1.04 cm	76.1 cm SD ±12.650 cm SE ±0.399 cm

		BMI	25.93 Kg/m2 SD ± 4.319 Kg/m2 SE ±0.4385 Kg/m2	17.62 Kg/m2 SD ±4.214 Kg/m2 SE ±0.1332 Kg/m2
Shushka Udara	386	Waist Circumference	54.4 cm SD ±6.067 cm SE ±0.3088 cm	62.4 cm SD ±10.651 cm SE ±0.3366 cm
		BMI	14.08 Kg/m2 SD ± 1.509 Kg/m2 SE ±0.076 Kg/m2	17.62 Kg/m2 SD ±4.214 Kg/m2 SE ±0.1332 Kg/m2
Shushka Sphik	382	Hip Circumference	66.6 cm SD ±8.742 cm SE ±0.447 cm	76.1 cm SD ±12.650 cm SE ±0.399 cm
Twagasthi Shesha	366	MUAC	18.3 cm SD ± 2.326 cm SE ±0.121 cm	21.4 cm SD ±3.801 cm SE ±0.120 cm
		Body Weight	27.0 kg SD ±8.316 kg SE ±0.434 kg	38.4 kg SD ±14.135 Kg SE ±0.446 Kg
		BMI	14.05 Kg/m2 SD ± 1.510Kg/m2 SE ±0.078 Kg/m2	17.62 Kg/m2 SD ±4.214 Kg/m2 SE ±0.1332 Kg/m2

Based on Ayurvedic parameters a very high prevalence of malnourishment (51%) with 112 (11.19%) children falling in the *Sthaulya* category and 399 (39.86%) children were under *Karshya* category was noted. In *Sthaulya* group, 61 (54.4%) children and in *Karshya* group 228 (57.14%) children belonged to urban areas. Number of girls was marginally high (58, 51.8%) in *Sthaulya* group while in *Karshya* group 228 (57.14%) were boys. The details of malnourished children based on BMI are presented in table no 4.

Table 4: Number of malnourished children based on BMI

Category	Underweight	Overweight	Obese	Total
Male	58 (51.32%)	100 (55.86%)	35 (45.45%)	193
Female	55 (48.67%)	79 (44.13%)	42 (54.54%)	176

Rural	55 (51.32%)	75 (41.89%)	32 (41.55%)	162
Urban	58 (48.67%)	104 (58.10%)	45 (58.44%)	207
Total	**113**	**179**	**77**	**369**

The comparative presentation of average BMI, WC, HC and MUAC of the children in the *Hina*, *Madhya* and *Adhika* groups of *Sthaulya* and *Karshya* are depicted in Image- 1, 2.

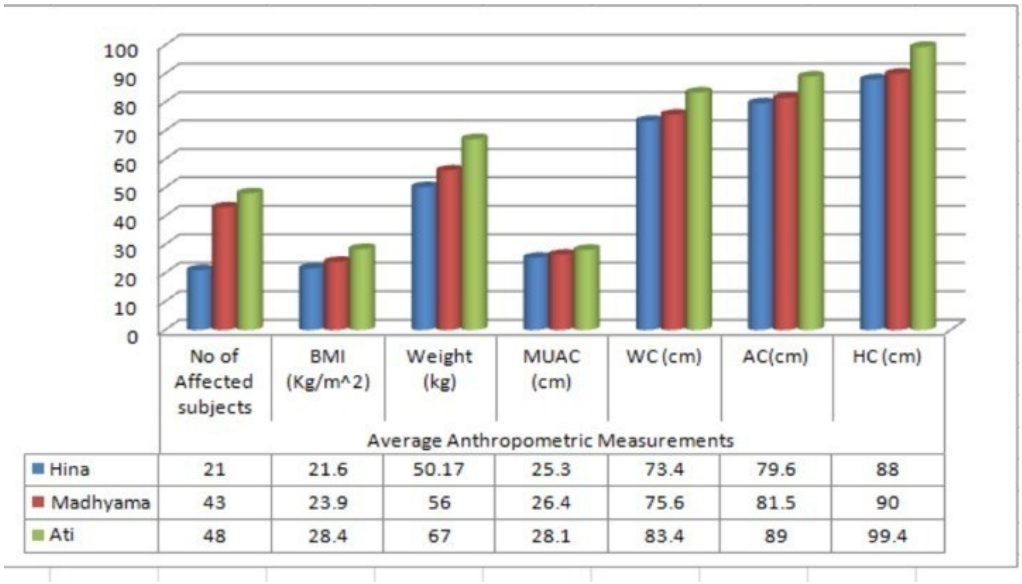

Image-1: Average Anthropometric values of *Hina*, *Madhya* & *Ati Sthaulya* groups

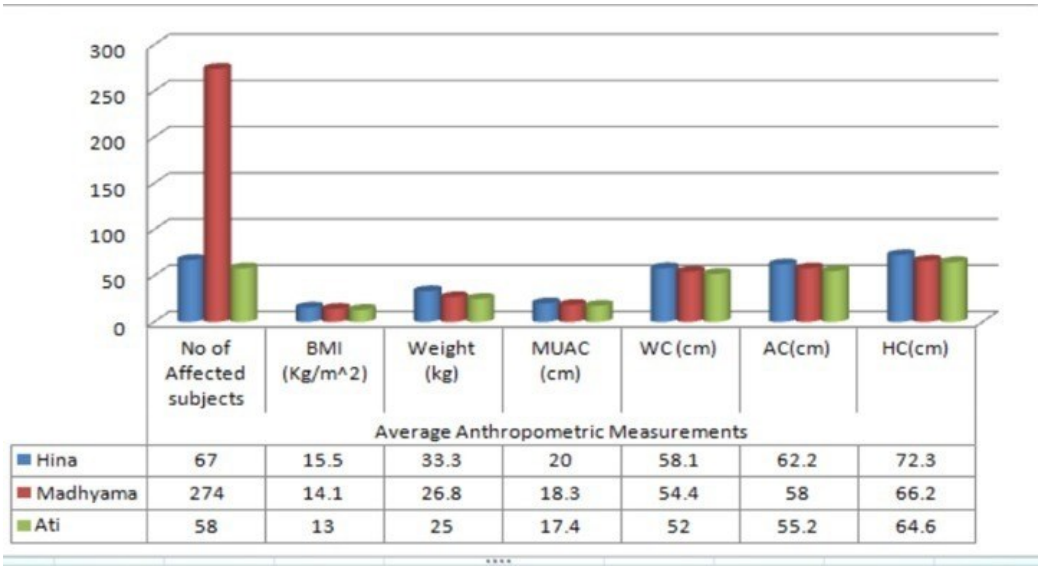

Image-2: Average Anthropometric values of *Hina*, *Madhya* & *Ati Karshya* groups

The number of positive symptoms of *Sthaulya* positively correlated with BMI with a correlation coefficient of 0.712508 and the number of symptoms of *Karshya* present was negatively

moderately correlated with BMI (correlation coefficient -0.68352). [Image 3] [Image 4]

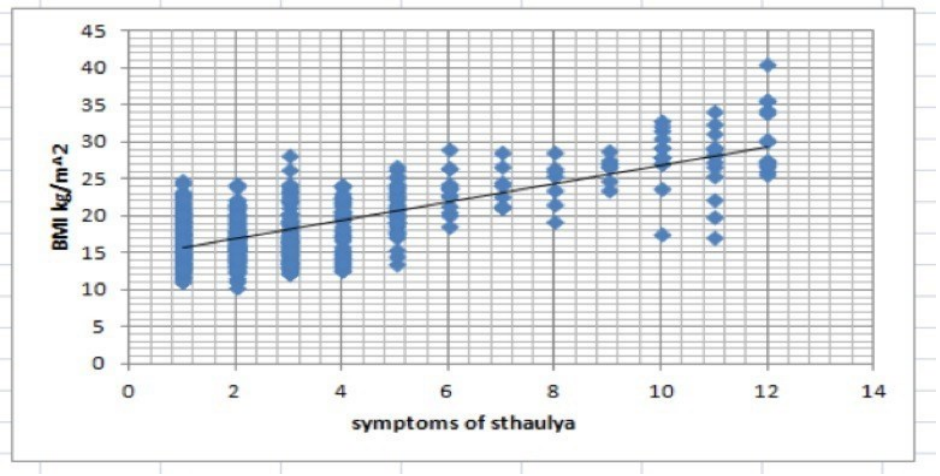

Image 3: Correlation of positive symptoms of *Sthaulya* with BMI

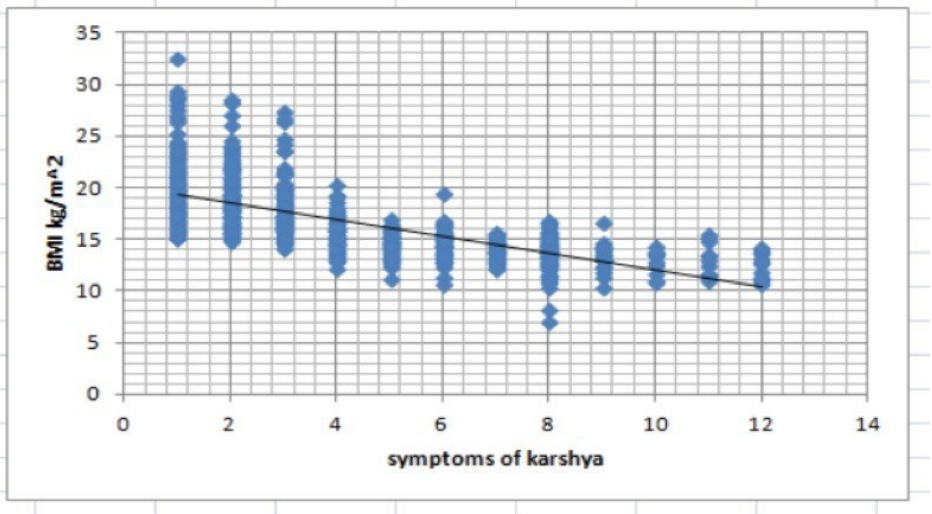

Image 4: Correlation of positive symptoms of *Karshya* with BMI

DISCUSSION:

Summary of key findings: The primary outcome measure of the study was the assertion of prevalence of malnourishment (51%) based on Ayurvedic parameters among school-going children. About 11.19% children were in *Sthaulya* (over-nourished) group and 39.86% were in *Karshya* (undernourished) group. The secondary outcome measure was an observance of a fair compatibility between assessment by Ayurvedic parameters and anthropometric measurements in the study.

Ayurvedic parameters identified 399 (36.86%) children in the *Karshya* group, whereas based on the IAP revised BMI growth charts, only 113 (11.29%) children were classified as underweight (less than 3rd percentile), indicating a 28.57% difference in prevalence compared to Ayurvedic parameters. This disparity is attributed to a high number of subjects categorized as *Hina* and *Madhya*

Karshya. The significant difference in prevalence between both methods and the observation of numerous children with symptoms like *Twagasthishesha*, *Shushka Udara,* and *Shushka Sphik* raised concerns about observational bias potentially inflating the number of children in the *Karshya* group.

However, the mean values of weight, BMI, HC, WC, AC, and MUAC of the children positive for these symptoms had a considerable downward departure from the overall mean of anthropometric measurements of all subjects. [Table-3] Also, number of positive symptoms present was proportional to the severity of malnutrition reflected by the mean values of anthropometric measurements and correlation graph. [Table 4]

It was observed that considerable number of children were at lower borderline of normal BMI range. For instance, between the range of 3rd to 5th percentile of the normal BMI range itself, there were 50 children. There is a possibility that the Ayurvedic parameters of *Karshya* were more sensitive and may have categorized the children lying at lower borderline of normal BMI range inside the *Karshya* group thus increasing the number of children in *Karshya* group.

The prevalence of *Karshya* established by this study corroborated the findings of many previous studies done using anthropometric measurements in the similar age groups. A previous study done among 935 school children in Karnataka found 50.05% children below the average weight for age.[11] Another study done on urban slum dwelling school going children of 5-15 years age puts prevalence of underweight from 35%-40% and prevalence of wasting from 31%-35.8% [12]

The National Family Health Survey (NFHS-5) conducted around the same time reported 35.2% of children in the underweight category in Karnataka, albeit for those below 5 years old. The Karnataka State Fact Sheet highlights that 26.1% of children below 5 years are wasted, with 10.5% severely wasted(weight-for-height).[13] The present study indicates a similar nutritional status among older children, suggesting the persistence of early childhood malnutrition into school age.

Noteworthy that based on BMI 256 (25.57%) children were over-nourished and among them 77 were obese and 179 were overweight. However, only 136 (13.58%) children were found in *Sthaulya* group based on Ayurvedic parameters. The possible cause for this discrepancy may be due to the fact that the symptoms of *Sthaulya* in Ayurveda represent only extreme cases of obesity, missing out completely the overweight and marginally obese children.

This study found that overweight and obesity were more prevalent in urban school children corroborating the findings of a previous study which suggests an increase in over-nutrition status among urban children and puts the prevalence of obesity at 11.7% in urban school children.[14] Both Ayurvedic parameters and anthropometric measures indicated towards

double burden of malnourishment among urban children as number of urban children was more in both *Sthaulya* and *Karshya* group with similar findings by BMI measurements.

Strengths of the study: The strength of this study is its design which enabled us to assess the prevalence of malnourishment with an Ayurvedic perspective despite several challenges. A serious impediment of insufficient available information, such as; *Adhika*, *Madhya* and *Hina* grades of *Sthaulya* without any clear description of the criteria for this classification was dealt by devising a grading system.[15] The three grades of *Sthaulya* and *Karshya* devised based on the number of positive symptoms was a novelty in the study and these grades were able to reflect the severity of malnourishment. The number of positive symptoms of *Sthaulya* and *Karshya* showed a fair correlation with BMI also.

Limitations of the study: Ayurvedic parameters of malnutrition may not always suffice for grading children, requiring supplemental anthropometric measurements. For instance, children reporting only subjective symptoms of *Sthaulya/Karshya* might not be considered malnourished if their weight, height, and BMI fall within the normal range. This highlights the need for a comprehensive assessment approach combining traditional and modern methods.

Children reporting only those subjective symptoms which are common for both *Sthaulya* and *Karshya* such as *Ayasa Asamrthata* (exercise intolerance), *Alpa Prana* (lack of energy), and *Kshut-pipasa Asamarthata/Ati Kshut Pipasa* (intolerance to hunger and thirst/excessive hunger & thirst) were also graded based on their anthropometric measurements. Present study chose to ignore terms *Karshya/Ati-Karshya* and *Sthaulya /Ati-Sthaulya* and taken them as *Sthaulya* and *Karshya* due to lack of clarity on differentiating the both.[16] Another downside was inability to use Ayurvedic anthropometric indices such as *Anguli Pramana* (finger width) which is used in Ayurveda as a personalized standardized measuring unit for the linear measurement of limbs and overall height.[17] Different opinions on defining the finger width and using self-finger width for measurement were major deterrents. *Anguli Pramana* was impractical and unsuitable tool for measuring height in this study where number of participants was high.[18] Body weight was not used as it remains an ignored index in assessment of all malnutritional conditions including *Sthaulya* and *Karshya* in Ayurveda despite availability of an elaborate *Mana Pramana* (weight measurement system).[19-21] Similarly, short stature and stunting are ignored as a feature of malnutrition in Ayurveda.[22,23] Hence, malnourishment was assessed based solely on the subjective and objective symptoms of *Sthaulya* and *Karshya*.

While efforts were made to minimize observers' bias, it may have influenced the reporting of objective symptoms. Participants' self-reporting

bias could have affected the reporting of subjective symptoms. Some participants hesitated or refused skin fold thickness measurements, impacting data precision. Time constraints from the funding agency and COVID-19 circumstances led to the trial not being registered in CTRI (Central Trial Registry of India).

Future research directions: This survey study offers an opportunity to integrate Ayurvedic insights on malnutrition into assessment practices. Subjective symptoms, often overlooked in anthropometric assessments, could improve upon diagnostic criteria. Future studies can refine observers' bias elimination through comprehensive grading and validation, fostering an integrative approach.

CONCLUSION:

Ayurvedic subjective and objective parameters of *Sthaulya* and *Karshya* identified a high prevalence of malnourishment (51%) among school-going children in this study. About 11.19% children were in *Sthaulya* (over-nourished) group and 39.86% were in *Karshya* (undernourished) group. In association with anthropometric measurements these parameters were able to provide a better insight into childhood malnutrition.

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Conflict of Interest: Second author is the member secretory of the institutional ethics committee. However, she abstained from the review process of this study and did not participate in decision making. First and third author has no conflict of interest to declare.

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