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COMPARISON OF NUTRITIONAL STATUS IN CHILDREN AGED 1–5 YEARS USING WHO (2006) AND INDIAN ACADEMY OF PEDIATRICS GROWTH CHARTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Undernutrition remains a leading cause of childhood morbidity in developing countries, and growth monitoring with standardized reference charts is central to its early detection. In India, both the World Health Organization (WHO) 2006 growth standards and the Indian Academy of Pediatrics (IAP) growth charts are used, but the two systems can classify the same child differently, creating uncertainty about the true burden of malnutrition.

Objectives: To compare the prevalence of undernutrition and stunting among children aged 1–5 years using WHO and IAP growth references, and to evaluate associations between nutritional status and selected demographic, socioeconomic and biological factors.

Methods: This cross-sectional study was conducted over two years among 689 children aged >1 to <5 years admitted to a tertiary-care hospital in Ahmedabad, India. Weight, height/length and mid-arm circumference (MAC) were measured by standard anthropometric technique and classified using IAP (percentage of Harvard median) and WHO (2006, Z-score) criteria. Categorical variables were compared using the chi-square test, with $p<0.05$ taken as significant.

Results: Of 689 children (328 male, 47.6%; 361 female, 52.4%), malnutrition (weight-for-age) was present in 44.7% (308/689) by IAP and 42.8% (295/689) by WHO criteria. Severe undernutrition (<−3SD) was identified in 23.4% (161) of children by WHO criteria, compared with 11.1% (76) classified as Grade III/IV by IAP. Stunting was more common by IAP (58.2%, 401/689) than by WHO criteria (35.3%, 243/689). By MAC, 30.6% of children were normal, 55.1% moderately and 14.3% severely malnourished. Malnutrition was significantly more prevalent among female children, in the 1–2-year age group, and among children from lower-income families, with unemployed mothers, low birth weight and higher birth order ($p<0.05$). Differences between WHO and IAP classification of both weight and height were statistically significant in male and female children ($p<0.05$).

Conclusion: WHO (2006) growth standards identified more severely malnourished children, while IAP charts identified more stunted children, than the alternative system. The choice of growth reference materially affects the estimated burden and severity of undernutrition in Indian preschool children, supporting the need for a standardized approach to pediatric growth monitoring.

Keywords: *Child Nutrition Disorders; Growth Charts; Anthropometry; Malnutrition; Growth Standards; Child, Preschool*

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INTRODUCTION

Adequate nutrition during the first five years of life is fundamental to a child's survival, physical growth, cognitive development and long-term health [1]. Malnutrition in early childhood increases susceptibility to infection, delays neurodevelopment, and is associated with higher mortality, with effects that can persist into adult life [1,2]. Growth monitoring-the serial measurement of weight, height and other anthropometric parameters plotted against a reference standard-is one of the simplest and least expensive screening tools for detecting nutritional, chronic systemic and endocrine disturbances at an early, potentially reversible stage [2]. In India, growth monitoring is a core activity of under-five clinics, where children are weighed at scheduled intervals and compared against reference charts to identify undernutrition and guide feeding interventions [2]. Current national policy, however, addresses growth monitoring only up to five years of age, and clinical practice varies widely because it is often not

evidence-based; the Indian Academy of Pediatrics (IAP) therefore issued consensus guidelines for growth monitoring under its 2006 Action Plan [2].

Anthropometric measurement remains the most practical direct method of nutritional assessment in both field and hospital settings, being non-invasive, inexpensive and reproducible. Weight-for-age reflects both acute and chronic nutritional deprivation, whereas height (or length)-for-age is considered a better index of long-standing, chronic undernutrition (stunting), since it responds relatively slowly to short-term deficits. Mid-arm circumference (MAC) changes little between one and five years of age and is a simple, rapid index for identifying children at nutritional risk. These measurements, plotted against an appropriate growth reference, form the basis for classifying a child as normally nourished, undernourished, stunted, or, less commonly in resource-limited settings, overweight or obese.

Historically, several reference populations have been used to construct growth charts, including the Harvard, National Center for Health Statistics (NCHS) and Centers for Disease Control and Prevention (CDC) standards [3]. In India, charts derived from the Harvard reference, subsequently adapted as the IAP classification, have been widely used in clinical practice, with nutritional status graded as a percentage of the expected Harvard median weight-for-age [2]. These references, however, were based largely on formula-fed children from a single population and did not adequately represent the growth pattern of breastfed infants or the diversity of the global child population [3]. To address these limitations, the World Health Organization (WHO) conducted the Multicentre Growth Reference Study (MGRS) between 1997 and 2003, enrolling healthy, predominantly breastfed infants from six countries (Brazil, Ghana, India, Norway, Oman and the United States) raised under conditions favourable to achieving their genetic growth potential [3,4]. The resulting WHO (2006) Child Growth Standards describe how children should grow under optimal conditions, expressed as standard-deviation (Z) scores from the median, rather than merely describing how a historical reference population did grow, and are now recommended for assessing children up to five years of age [4].

Because the IAP and WHO systems differ in their reference population, in the statistical approach used to define abnormal growth (percentage of the median versus Z-score), and in the age range they cover, the same child can be classified differently-as normal, moderately malnourished or severely malnourished-depending on which chart is applied [4]. Such discordance has direct implications for clinical decision-making, targeting of nutrition-rehabilitation programmes, and the accuracy of population-level estimates of the burden of undernutrition. Several Indian studies have reported differing prevalence estimates of underweight and stunting depending on the growth reference used, but head-to-head comparisons of WHO and IAP classification in hospital-based pediatric populations remain limited, particularly with attention to associated socio-demographic and biological correlates.

The present study was therefore undertaken to assess and compare the nutritional status of children aged 1–5 years using the WHO (2006) and IAP growth references, and to examine the association of nutritional status with age, sex, and selected socioeconomic and biological factors, including parental occupation, family income, birth order, birth weight, immunization status and anemia.

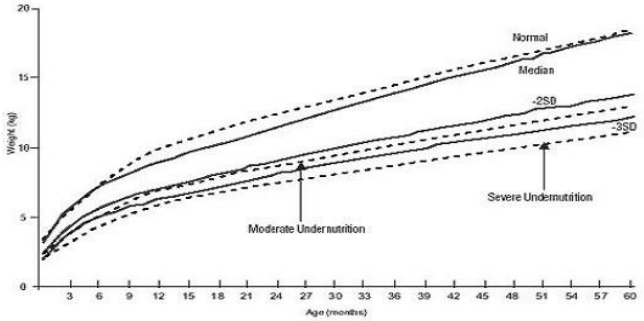

Figure 01: Comparison of WHO (2006) and IAP weight-for-age reference curves (0–60 months), showing the median and the cut-offs used to define moderate and severe undernutrition under each system.

MATERIALS AND METHODS

Study design, duration and setting

This was a hospital-based, cross-sectional observational study conducted over a period of two years in the Department of Pediatrics of a tertiary-care teaching hospital in Ahmedabad, Gujarat, India.

Study population

Children aged more than 1 year and less than 5 years, admitted to the hospital and belonging predominantly to middle and low socioeconomic strata of the urban population, were eligible for enrolment. Children fulfilling eligibility criteria were enrolled consecutively during the study period; a total of 689 children were studied. A formal a-priori sample-size calculation was not reported in the source study.

Inclusion Criteria: children aged >1 year and <5 years admitted to the hospital.

Exclusion criteria: children aged <1 year or >5 years; children with musculoskeletal or neurological disease likely to affect anthropometric measurement.

Data collection

A structured proforma was used to record demographic details (age, sex, religion, address), birth weight, parental educational status and occupation, family income, socioeconomic status, birth order, immunization status, chief complaints, anthropometric measurements, grade of anemia, vitamin deficiency, duration of hospital stay and clinical outcome.

Anthropometric measurements

Weight was measured using a personal weighing balance with minimal clothing; children weighing up to 10 kg were weighed on an infant weighing scale. Recumbent length was measured in children aged 1–2 years using a horizontal measuring board with a fixed head-piece and mobile foot-piece; standing height was measured in children above 2 years using a non-stretchable fibreglass tape fixed vertically to a wall, with the child positioned with heels, buttocks, shoulders and occiput touching the wall and the head held in the Frankfurt plane, measured to the nearest 1 cm. Mid-arm circumference (MAC) was measured on the left arm midway between the acromion and olecranon using a non-stretchable tape, to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Classification of nutritional status

Weight-for-age was classified by IAP criteria (percentage of expected Harvard-standard median) as normal (>80%), Grade I/mild (71–80%), Grade II/moderate (61–70%), Grade III/severe (51–60%) and Grade IV/very severe (<50%), and independently by WHO (2006) Z-score criteria as normal (−2SD to +2SD), moderate undernutrition (−2SD to −3SD), severe undernutrition (<−3SD), overweight (+2SD to +3SD) and obese (>+3SD). Height-for-age was classified by IAP/percentage-of-median criteria as normal (>95%), mild stunting (90–95%), moderate stunting (85–90%) and severe stunting (<85%), and by WHO Z-score criteria as normal (>−2SD), moderate stunting (−2SD to −3SD) and severe stunting (<−3SD). MAC was classified as normal (>13.5 cm), moderate protein-energy malnutrition (12.5–13.5 cm) or severe protein-energy malnutrition (<12.5 cm).

Statistical analysis

Data were tabulated and expressed as frequencies and percentages for categorical variables. Associations between nutritional grade and sex, age group, and socio-demographic and biological variables (parental occupation, family income, birth order, birth weight, immunization status and anemia) were tested using the chi-square test, and differences between WHO and IAP classification were similarly tested; a two-tailed p value <0.05 was considered statistically significant. The specific statistical software used was not stated in the source dissertation.

Ethical considerations

Formal documentation of institutional ethics committee approval and parental informed consent was not detailed in the source dissertation.

RESULTS

Study population

A total of 689 children aged 1–5 years were studied, comprising 328 (47.6%) males and 361 (52.4%) females. The largest proportion of children (242, 35.1%) belonged to the 1–2-year age group, followed by 3–4 years (159, 23.1%), 4–5 years (157, 22.8%) and 2–3 years (131, 19.0%).

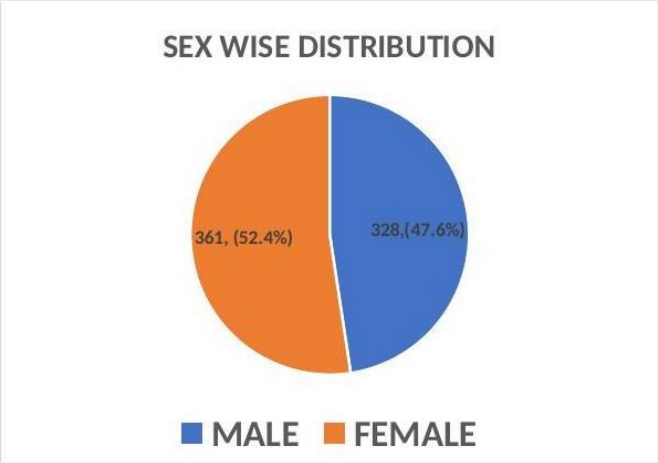

Figure 02: Sex-wise distribution of study children (N=689).

Nutritional status: weight-for-age

The prevalence of undernutrition by IAP criteria (weight-for-age <80% of the expected median) was 44.7% (308/689): Grade I 140 (20.3%), Grade II 92 (13.3%), Grade III 55 (8.0%) and Grade IV 21 (3.1%). By WHO (2006) Z-score criteria, an abnormal weight-for-age was present in 42.8% (295/689) of children when both undernutrition and excess weight were considered: moderate undernutrition (−2SD to −3SD) 113 (16.4%) and severe undernutrition (<−3SD) 161 (23.4%), together with 13 children (1.9%) who were overweight and 8 (1.1%) who were obese by WHO criteria (Table 1). Malnutrition (IAP) was more prevalent among female children (170/361, 47.1%) than male children (138/328, 42.1%); severe and very severe malnutrition were also more frequent among females (severe 31/361, 8.6%; very severe 15/361, 4.2%) than males (severe 24/328, 7.3%; very severe 6/328, 1.8%), a difference that was statistically significant (p<0.01). By age group, the prevalence of malnutrition (IAP) was highest in the 1–2-year age group (131/242, 54.1%) and lowest in the 2–3-year age group (47/131, 35.9%).

Nutritional status: height-for-age (stunting)

Stunting was considerably more common when assessed by IAP criteria — 401/689 (58.2%), of whom 52 (7.5%) were severely stunted — than by WHO criteria — 243/689 (35.3%), of whom 100 (14.5%) were severely stunted. Severely stunted children were most frequent in the 1–2-year age group by both IAP (34/52, 65.3%) and WHO (66/100, 66.0%) classification, and least frequent in the 2–3-year age group.

Mid-arm circumference

Using MAC, 211 children (30.6%) were classified as normal (>13.5 cm), 380 (55.1%) as moderately malnourished (12.5–13.5 cm) and 98 (14.3%) as severely malnourished (<12.5 cm).

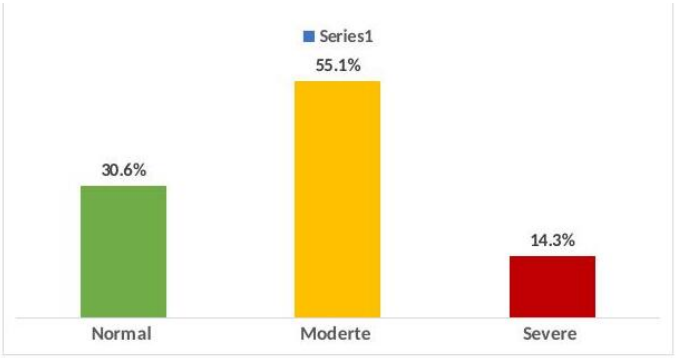

Figure 03: Nutritional status of study children by mid-arm circumference (MAC) category (N=689).

Comparison between WHO and IAP standards

The number of children classified as having a normal weight-for-age was consistently higher by IAP than by WHO criteria in both sexes: 246 (IAP) versus 185 (WHO) among males (p<0.0001), and 275 (IAP) versus 230 (WHO) among females (p=0.0003). A similar pattern was observed for height-for-age, with more children classified as normal by IAP than by WHO criteria among males (256 vs 195, p<0.00001) and females (297 vs 251, p<0.00023) (Table 2). Overall, WHO criteria classified fewer children as normal, and correspondingly more as moderately or severely affected, than IAP criteria for both weight and height.

Socioeconomic and biological associations

Malnutrition was more prevalent among children from families with a monthly income below Rs. 10,000 (280/604, 46.3%) than among those with an income above Rs. 10,000 (28/85,

33.0%); all 21 children with very severe malnutrition belonged to the lower-income group. No statistically significant association was found between paternal employment and nutritional status (441/689 fathers were unemployed). Malnutrition was less frequent among children of employed mothers-4/66 (6.1%) moderately malnourished and none severely malnourished-than among children of unemployed mothers, among whom 88/623 (14.1%) were moderately, 55/623 (8.8%) severely and 21/623 (3.4%) very severely malnourished. Normal nutritional status was present in 61.8% of first-born children compared with 53.4% of second-born and 53.5% of third-or-higher-order births, with malnutrition increasing significantly with birth order ($p<0.05$). Malnutrition prevalence rose sharply with decreasing birth weight, from 38.0% among children weighing >2.5 kg at birth to 94.1% among those weighing <2 kg ($p<0.01$). Of 689 children, 538 (78.1%) were completely immunized, 147 (21.3%) incompletely immunized and 4 (0.6%) unvaccinated; all four unvaccinated children were severely malnourished, and severe malnutrition was more frequent among incompletely immunized children (77/147, 52.4%) than among completely immunized children (80/538, 14.9%). With respect to anemia, 206 children (29.9%) had none, while 256 (37.2%), 130 (18.9%) and 97 (14.1%) had mild, moderate and severe anemia respectively; malnutrition of moderate-to-very-severe grade was more frequent among anemic than non-anemic children.

Table 01: Nutritional status (weight-for-age) of children aged 1–5 years (N=689) by IAP and WHO (2006) classification

Nutritional grade	IAP criterion (% median wt-for-age)	IAP n (%)	WHO (2006) criterion (Z-score)	WHO n (%)
Normal	>80%	381 (55.3)	−2SD to +2SD	394 (57.2)
Mild (Grade I)	71–80%	140 (20.3)	—	—
Moderate (Grade II)	61–70%	92 (13.3)	−2SD to −3SD	113 (16.4)
Severe (Grade III)	51–60%	55 (8.0)	<−3SD	161 (23.4)
Very severe (Grade IV)	<50%	21 (3.1)	—	—
Overweight	—	—	+2SD to +3SD	13 (1.9)
Obese	—	—	>+3SD	8 (1.1)
Total		**689 (100)**		**689 (100)**

Table 02: Comparison of WHO and IAP classification of weight-for-age and height-for-age by sex

Parameter	Sex (N)	Classification	WHO, n	IAP, n	p value
Weight-for-age	Male (328)	Normal	185	246	<0.0001
		Moderate	67	52	
		Severe	76	30	
	Female (361)	Normal	230	275	0.0003
		Moderate	46	40	
		Severe	85	46	
Height-for-age	Male (328)	Normal	195	256	<0.00001
		Moderate	80	43	
		Severe	53	29	
	Female (361)	Normal	251	297	0.00023
		Moderate	63	41	
		Severe	47	23	

DISCUSSION

This hospital-based study of 689 children aged 1–5 years found a broadly similar overall prevalence of malnutrition by IAP (44.7%) and WHO (42.8%) weight-for-age criteria, but marked differences in the distribution of severity, and in the extent of stunting identified, by the two systems. The overall prevalence of malnutrition observed here is comparable to reports from other urban Indian settings. Ghosh et al., studying urban slum children in Kolkata, reported a malnutrition prevalence of approximately 51%, similar to the IAP-based estimate in the present study, while their data from Delhi (58%) were somewhat higher [7]. Ray et al. reported a higher prevalence (63%) in a municipal population of Kolkata.(8) Using WHO criteria, Bhanderi and Choudhary reported an underweight prevalence of 43.7% in a semi-urban Gujarati population, closely matching the WHO-based estimate in the present study (42.8%), whereas Sachdev reported a considerably higher prevalence (61.2%), and Rama Rao a lower prevalence (37%), of underweight in preschool children [6,9,10].

Severe malnutrition (<−3SD by WHO criteria) was present in 23.4% of children in this study, somewhat higher than the approximately 20% reported by Ramachandran in preschool children from Delhi, but lower than the 33.3% reported by Sachdev.(5,9) Within the grade distribution reported here, WHO criteria classified 57.2% of children as having a normal weight-for-age, a pattern broadly comparable with the combined normal and moderately-undernourished

proportions reported by Gunasekaran et al. using anthropometric criteria in Tamil Nadu [11].

A more striking difference between the two reference systems was observed for stunting: 58.2% of children were stunted by IAP criteria compared with 35.3% by WHO criteria-a pattern opposite to that reported by Savitha and Kondapuram, who found a higher stunting prevalence using WHO criteria (78.8%) than IAP criteria (62.3%) in south Indian preschool children [12]. This divergence likely reflects differences in the underlying reference populations and statistical approach: the IAP chart classifies stunting as a percentage deviation from the Harvard median, whereas the WHO chart uses a standard-deviation (Z-score) approach derived from a multi-country sample of optimally growing, predominantly breastfed children, and may also reflect differences in the regional growth patterns of the respective study populations. In the present study, differences between WHO and IAP classification for both weight and height were statistically significant in both male and female children ($p<0.05$); this was also true for stunting in the study by Savitha and Kondapuram, although in their data the difference in malnutrition prevalence between systems reached significance only in male children, in contrast with the significant difference observed in both sexes in the present study [12].

Malnutrition was more prevalent, and severe grades more common, among female children in this study ($p<0.01$), consistent with the findings of Ghosh et al., in whose study female children were also more likely to have severe grades of malnutrition [7]. This contrasts with the report by Ray et al., in which the male–female difference in overall malnutrition prevalence was not statistically significant, despite a similarly greater burden of severe malnutrition among female children [8].

The present data also confirm well-established socio-biological correlates of undernutrition. Malnutrition was significantly more prevalent among children from lower-income families, consistent with the association between socioeconomic status and malnutrition reported by Bhanderi and Choudhary [6]. It was inversely related to birth weight, in keeping with reports from Sri Lanka and from Rama Rao that low-birth-weight infants tend to have poorer subsequent nutritional status [10, 15]. Increasing birth order was associated with a higher prevalence of malnutrition, similar to the pattern of increasing wasting with family size described by Ruamtham et al. in Thailand [14]. Maternal employment appeared protective in this cohort, while paternal employment showed no clear association with nutritional status, a finding also reported by Rama Rao [10].

The differences observed between IAP and WHO classification are consistent with recognized methodological distinctions between the two systems. The WHO (2006) standards are prescriptive rather than descriptive: they describe how children from an optimally nourished, predominantly breastfed international reference population should grow, rather than merely how a historical reference population did grow, and are derived from a pooled sample across six countries rather than a single national population [4]. In contrast, the IAP charts, based on affluent urban Indian children measured between 1989 and 1991, remain widely used in India because they extend to 18 years of age, unlike the WHO standards, which are validated only up to five years [13]. The WHO charts additionally incorporate BMI-for-age, permitting simultaneous identification of undernutrition and overweight/obesity-the double burden of malnutrition increasingly seen in transitioning populations such as urban India-reflected in this study by the small but definite proportion of children identified as overweight (1.9%) or obese (1.1%) only by WHO criteria.(4)

Clinically, these findings suggest that the choice of growth reference can materially change the estimated burden of undernutrition and stunting in a given population, with implications for resource allocation, eligibility for nutrition-rehabilitation programmes, and the comparability of surveillance data across studies that use different charts. This study is limited by its hospital-based, cross-sectional design, which may not reflect the nutritional status of the general community, by the absence of a documented sample-size calculation, and by the lack of explicit reporting of ethical-approval procedures in the source data.

CONCLUSION

In this cross-sectional study of 689 children aged 1–5 years, the overall prevalence of undernutrition was broadly similar whether assessed by IAP (44.7%) or WHO (2006) (42.8%) weight-for-age criteria, but WHO criteria identified a substantially higher proportion of children with severe malnutrition, while IAP criteria identified a higher proportion of children as stunted (58.2% vs 35.3% by WHO). Malnutrition was highest in the 1–2-year age group and lowest at 2–3 years, was more prevalent among female children, and was significantly associated with lower family income, unemployed maternal status, low birth weight and higher birth order. These findings indicate that the choice of growth reference has a measurable effect on the estimated prevalence and severity of undernutrition and stunting in Indian preschool children, and support the use of a single standardized growth reference-consistent with WHO recommendations–for pediatric growth monitoring and nutritional surveillance, while acknowledging the continued clinical utility of IAP charts, particularly beyond five years of age.

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CONFLICT OF INTEREST

None Informed Consent

TAKEN ETHICAL STATEMENT

Not applicable

AUTHOR CONTRIBUTION

Sole author was responsible for all aspects of this work

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