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Original Article

Nutrition Section

# Efficacy of Subjective and Objective Nutritional Assessment in Children: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Globally, malnutrition represents a critical health concern, particularly among children. Research has consistently shown that undernutrition is highly prevalent in children admitted to hospitals, with reported rates ranging from 21-80%. This widespread issue significantly affects children and their families, impacting their physical, social and economic wellbeing, while also posing serious challenges for healthcare systems.

**Aim:** To measure the nutritional status of children aged 2 to 12 years using both objective and subjective global nutritional assessments.

**Materials and Methods:** This cross-sectional study was conducted to assess the nutritional status of children aged 2 to 12 years at ACS Medical College and Hospital, Chennai, Tamil Nadu, India between January 2024 and March 2024. Using both objective and subjective global nutritional assessments, the study evaluated children's nutritional status through anthropometric measurements and physical examinations. The objective assessment included measurements of height, weight, Mid-Arm Circumference (MAC) and Triceps Skinfold Thickness (TSF), while the subjective global assessment involved a physical examination and a review of medical history. These methods were chosen based on a literature review comparing subjective and objective nutritional assessments in children. Data were analysed using Statistical Package for the Social Sciences (SPSS) software version 21.0 to compare nutritional indicators between well-nourished and malnourished children, with significance set at p-value <0.05.

**Results:** The study included 250 children (mean age: 5.61±2.89 years). According to the subjective global assessment, 52% of the children were malnourished, while the objective assessment identified 66.4% as malnourished. Well-nourished children had higher measurements in height (109.9±20.6 cm vs. 106.8±19.26 cm), weight (19.6±9.4 kg vs. 17.51±10.4 kg), Body Mass Index (BMI) (15.69±3.03 vs. 15.1±3.85), TSF (11.05±3.62 mm vs. 10.17±3.14 mm), and MAC (17.28±2.59 cm vs. 15.87±2.52 cm). The subjective global assessment showed fair agreement with the objective measures (κ=0.317, p-value <0.0001). These findings emphasise the necessity of using both subjective and objective assessments for a comprehensive evaluation of paediatric nutritional status.

**Conclusion:** The study highlights significant differences in growth and body composition between well-nourished and undernourished children. The objective markers reflect the impact of malnutrition, while the fair agreement (κ=0.317) between subjective global assessment and objective assessments underscores their complementary value. This emphasises the need for an integrated approach to assess nutritional status and guide targeted interventions accurately.


**Keywords:** Childhood malnutrition, Malnutrition, Subjective global assessment

## INTRODUCTION

According to the World Health Organisation (WHO), malnutrition refers to deficiencies, excesses, or imbalances in energy and nutrient intake and includes three main types: undernutrition, micronutrient-related malnutrition and overnutrition. Undernutrition includes wasting, stunting and underweight, while micronutrient-related malnutrition involves deficiencies or excesses of vitamins and minerals. Overnutrition, which includes overweight and obesity, can lead to diet-related non communicable diseases such as heart disease and diabetes [1].

Malnutrition, particularly undernutrition, is a critical global health concern, especially among hospitalised paediatric patients. Studies report undernutrition prevalence rates among hospitalised children ranging from 21-80%, depending on socio-economic context and the level of country development [2,3]. Malnutrition remains a significant concern in hospitalised patients, with studies showing that nearly half of patients with digestive diseases are malnourished, as assessed by the Subjective Global Assessment, highlighting the importance of effective nutritional screening in paediatric populations [4]. Undernutrition poses significant healthcare challenges and negatively impacts the physical, social and economic wellbeing of children and their families. A study by Parameswaran N observed a greater reduction in stunting (16%) compared to underweight (10%) among Indian children under five years from 1992 to 2016, indicating consistent improvement in childhood nutrition indicators, albeit at a slower pace than desired [5]. Malnutrition also impairs children's quality of life, affecting their daily activities, school participation and social interactions [6].

Early identification of malnutrition and timely intervention are crucial. Traditional nutritional assessment methods, such as anthropometric measurements, dietary assessments, biochemical markers and immunological assays, are often time-consuming, costly and challenging, especially in resource-limited settings [7]. There is a need for practical, efficient and non invasive tools for the timely identification of undernourished paediatric patients. The Subjective Global Assessment, introduced by Detsky AS et al., in their study on clinical nutritional assessment, is a promising approach for adults, providing a comprehensive screening tool based on a clinician's evaluation of medical history and physical examination findings [8]. Shirodkar M and Mohandas KM, highlighted that the Subjective Global Assessment serves as a simple yet reliable tool for identifying malnutrition in Indian populations. Their study emphasised its practicality in clinical settings, particularly where traditional assessment methods may not be feasible [9]. Despite its widespread use in

adults, the utility of the Subjective Global Assessment in paediatric patients remains to be fully explored. Studies have investigated the ability of the Subjective Global Assessment to identify malnutrition and complications in children [6,10].

Growth charts are essential for monitoring children's nutrition and development. The Indian Academy of Paediatrics (IAP) created IAP 2015 Growth Charts for children aged five to eighteen and suggested WHO Growth Charts for children under five [1,11]. These charts allow for continuous monitoring from birth to eighteen years on a single chart, showing the relationship between a child's height and mid-parental height [11]. This study aimed to evaluate the performance of the Subjective Global Assessment in paediatric nutritional assessment by comparing it with objective assessments, including anthropometric and biochemical measurements in hospitalised paediatric patients.

## MATERIALS AND METHODS

The present cross-sectional study evaluated the nutritional status of paediatric patients aged 2 to 12 years at the outpatient department of ACS Medical College and Hospital, Velappanchavadi, Chennai, Tamil Nadu, India, over a period from January 2024 to March 2024. Ethical approval was obtained from the Institutional Ethics Committee (IEC) (Approval Reference Number: 1017/2023/IEC/ACSMCH, dated 17/11/2023) and informed consent was secured from guardians to ensure participant confidentiality.

**Inclusion criteria:** Children aged 2-12 years and their parents, who were willing to provide informed consent, were included in the study. The 2-12 years age group was selected to focus on early and middle childhood, which are critical periods for growth and development where nutritional interventions can have the most impact. This age range allows for a more targeted analysis of nutritional status, minimising variability and providing clearer insights into this specific developmental stage.

**Exclusion criteria:** Children who were chronically ill were excluded from the present study.

**Sample size:** The required sample size was calculated based on an assumed malnutrition prevalence of 50% [12] in the population, with an absolute precision of 6% and a 95% confidence interval. This yielded a sample size requirement of 267 subjects.

### Study Procedure

**Subjective assessment:** Data collection involved administering a standardised Subjective Global Assessment questionnaire [Annexure-1], which assessed dietary intake, weight changes, gastrointestinal symptoms, functional capacity and physical examination findings, focusing on muscle wasting and subcutaneous fat loss [8,13,14]. Based on a prior study conducted in Turkey by Nursal TZ et al., a score of 10 was identified as the threshold for the Subjective Global Assessment. Individuals scoring below 10 were considered well-nourished, while those with a score of 10 or above were classified as undernourished [8,15].

**Objective assessment:** Objective measurements included height, weight, skinfold thickness and MAC. Weight-for-height, weight-for-age, height-for-age and BMI-for-age were obtained using precise tools and standardised protocols [1]. Height was measured using a stadiometer with specific positioning, and weight was measured using a flat-surface scale. BMI-for-age, weight-for-height, weight-for-age, and height-for-age were assessed using the WHO growth charts as standard references [1]. For each child, BMI was calculated by dividing weight (kg) by height squared ($m^2$), which was then plotted against age on the WHO BMI-for-age growth chart. Weight-for-height and height-for-age were measured by recording each child's weight and height and comparing these measurements to age-appropriate percentiles on the WHO growth charts to assess nutritional status. Weight-for-age was similarly assessed by plotting individual weights against age on the weight-for-age chart. Each measurement allowed for the categorisation of children into growth percentiles, providing a standardised way to identify undernutrition or overnutrition. Skinfold thickness was measured with calipers and MAC was measured with a tape at the midpoint between the shoulder and elbow. This study demonstrated the value and limitations of subjective and objective evaluation methods in assessing paediatric nutritional status.

## STATISTICAL ANALYSIS

Statistical analysis was conducted using SPSS software version 21.0. Data were presented as means±SD, with a p-value <0.05 considered indicative of statistical significance. Data analysis included the kappa statistic for agreement between the Subjective Global Assessment and objective assessments, as well as calculations of sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) for the Subjective Global Assessment. Additionally, statistical indicators such as error rates, accuracy positive and negative predictive powers, likelihood ratios and odds ratios were determined according to established formulas.

## RESULTS

The study involved 250 participants, with a mean age of 5.61±2.89 years. For all participants, mean±SD values for height, weight, BMI, TSF and MAC were measured [Table/Fig-1]. The well-nourished group (N=120) had a mean height of 109.9±20.6 cm, while the undernourished group (N=130) had a mean height of 106.8±19.26 cm. Similarly, the well-nourished individuals had a higher weight (19.6±9.4 kg) compared to the undernourished group (17.51±10.4 kg). Body Mass Index (BMI) was also higher in the well-nourished group (15.69±3.03 kg/$m^2$) compared to the undernourished group (15.1±3.85 kg/$m^2$). TSF and MAC measurements were greater in the well-nourished group as well (TSF: 11.05±3.062 mm; MAC: 17.28±2.59 cm) compared to the undernourished group (TSF: 10.17±3.14 mm; MAC: 15.87±2.52 cm) [Table/Fig-1]. Furthermore, indicators such as weight-for-height, weight-for-age, height-for-age, and BMI-for-age were all higher in the well-nourished group than in the undernourished population, indicating a better overall nutritional status in the well-nourished individuals. The sensitivity, specificity, PPV and NPV between the Subjective Global Assessment and the objective assessments were 63.06%, 74.32%, 85.38%, and 45.83%, respectively [Table/Fig-2]. The sensitivity (63.06%) of the Subjective Global Assessment in identifying undernourished individuals reflects its moderate ability, which is considered acceptable compared to standard benchmarks for nutritional assessment tools in paediatric populations, typically ranging between 60% and 80% depending on the tool and context [Table/Fig-2].

| Variables | Subjective assessment | | Objective assessment | |
|---|---|---|---|---|
| | Well nourished (N=120) | Undernourished (N=130) | Well nourished (N=84) | Undernourished (N=166) |
| Height (cm) | 109.9±20.6 | 106.8±19.26 | 115.8±20.4 | 105.2±22.7 |
| Weight (kg) | 19.6±9.4 | 17.51±10.4 | 22.2±2.48 | 17±9.99 |
| BMI (kg/$m^2$) | 15.69±3.03 | 15.1±3.85 | 16.09±2.48 | 15.16±3.59 |
| TSF (mm) | 11.05±3.62 | 10.17±3.14 | 12.57±3.01 | 9.76±3.47 |
| MAC (cm) | 17.28±2.59 | 15.87±2.52 | 17.6±3.23 | 15.7±3.16 |
| Weight for height (%) | 97±21.9 | 92.14±20.51 | 101.3±23.3 | 91.62±21.95 |
| Weight for age (%) | 97.9±10.52 | 88.5±22 | 105.6±28.45 | 86.9±24.9 |
| Height for age (%) | 96.2±26.58 | 94.7±12.12 | 101±11.89 | 94.22±12.6 |
| BMI for age (%) | 100±19.24 | 99.4±25.5 | 103.7±18.47 | 98.09±23.24 |

**[Table/Fig-1]:** Patient anthropometric data by nutritional status (N=250).
TSF: Triceps Skin fold thickness; MAC: Mid arm circumference; BMI: Body mass index;
#The parameters weight for height, weight for age, height for age, and BMI for age are expressed as a percentage of the reference median, rather than as percentiles

| Indicators | Values* |
|---|---|
| Sensitivity | 63.06 |
| Specificity | 74.32 |
| Positive Predictive Value (PV+) | 85.38 |
| Negative Predictive Value (PV-) | 45.83 |
| False positive error rate | 25.67 |
| False negative error | 36.93 |
| Accuracy | 66.4 |
| Positive power# (PO+) | 59.92 |
| Negative power (PO-) | 39.56 |
| Likelihood ratio positive (LR+) | 2.42 |
| Likelihood ratio negative (LR-) | 0.5 |
| Odds ratio (OR) | 4.84 |

**[Table/Fig-2]:** Statistical indicators of subjective global assessment against objective assessment.
#The objective assessment was taken as gold standard

According to the Subjective Global Assessment, 48% (120 participants) were categorised as not at risk of malnutrition, while 52% (130 participants) were identified as at risk [Table/Fig-3]. Objective assessments indicated that 33.6% (84 participants) were well-nourished, whereas 66.4% (166 participants) were undernourished. A comparison was made between these groups across various variables.

| Subjective global assessment | Objective assessment | | |
|---|---|---|---|
| | Malnourished | Well nourished | Total |
| At risk of malnutrition (+) | TP (111) | FP (19) | 130 |
| Not at risk of malnutrition (-) | FN (55) | TN (65) | 120 |
| Total | 166 | 84 | 250 |

**[Table/Fig-3]:** Classification of 250 patients according to the subjective global assessment and the objective assessment.
k=0.317, p<0.000, TP: True positive; FP: False positive; TN: True negative; FN: False negative

The specificity was 74.32%, and the ability of the Subjective Global Assessment to predict objective assessment of nutritional status is illustrated in [Table/Fig-3].

Sixty-five patients were correctly classified by the Subjective Global Assessment as being well-nourished (true negatives), while 111 patients were correctly classified as being undernourished (true positives). There was fair agreement between the subjective and objective assessments (κ=0.317, p-value <0.0001).

## DISCUSSION

According to the study conducted by Mahdavi AM et al., in Iran, the prevalence of undernutrition in children, as assessed by the Subjective Global Assessment, was approximately 70.7%, which was 22.2% higher than that determined by objective assessment [10]. In contrast, present study found that 52% of participants were categorised as undernourished according to the Subjective Global Assessment, while 66.4% were identified as undernourished based on objective assessment. The prevalence of undernutrition in present study population, as assessed by the Subjective Global Assessment, contrasts with findings in Canada (51%) by Secker DJ and Jeejeebhoy KN, in Thailand (35.9%) by Rojratsirikul C et al., and in Iran (70.7%) by Mahdavi AM et al., [6,10,16]. Studies have reported varying prevalence rates, attributed to differences in dietary patterns, socio-economic status and co-morbidities across different countries [6,10].

The well-nourished children in present study exhibited higher average heights and weights compared to their malnourished counterparts. This finding was consistent with previous research indicating that malnutrition adversely affects linear growth and body mass accumulation [17]. For instance, a study by Blossner M and de Onis M, emphasised that malnutrition, particularly in early childhood, leads to stunted growth and decreased body weight, adversely impacting overall health and development [18]. Similarly, in present study, BMI—an essential indicator of body fat and overall nutritional status—was higher in well-nourished children. This finding aligns with the work of Bhutta ZA et al., who highlighted that children suffering from malnutrition often present with lower BMI due to insufficient caloric intake and nutrient deficiencies [19]. Additionally, TSF and MAC were significantly higher in well-nourished children. These measures reflect body fat and muscle mass, both of which are crucial for healthy growth and development. According to Jana V, TSF and MAC are reliable indicators of protein-energy malnutrition, and their reduced values in malnourished children indicate deficits in both fat and muscle tissue [20].

In present study, nutritional indices (weight-for-height, weight-for-age, height-for-age, and BMI-for-age) consistently demonstrated better values in well-nourished children. This finding aligns with the Global Nutrition Report 2020, which showed that children with adequate nutrition tend to achieve better scores across these indices, reflecting healthier growth patterns and a reduced risk of developmental issues [21]. The sensitivity of the Subjective Global Assessment in present study was 63.06%, and the specificity was 74.32%. The false positive error rate was 25.67%, and the false negative error rate was 36.93%, highlighting the limitations of the Subjective Global Assessment. This underscores the need for caution and suggests that combining the Subjective Global Assessment with other assessment methods could be beneficial. The overall accuracy of the Subjective Global Assessment in present study was 66.4%, with a PPV of 59.92% and a NPV of 39.56%, which was consistent with other studies reporting moderate accuracy for the Subjective Global Assessment in clinical settings.

When comparing well-nourished and undernourished children based on anthropometric measurements, present study found significant differences, supporting the need for comprehensive nutritional assessments. This study corroborates existing literature on the adverse effects of malnutrition on children's growth and nutritional status, emphasising the importance of detailed anthropometric data in assessing nutritional status and guiding interventions [13].

### Limitation(s)

Discrepancies between the Subjective Global Assessment and objective assessments in present study highlight the challenges in nutritional evaluation.

## CONCLUSION(S)

Based on the study findings, a comprehensive and integrated approach is essential for accurately assessing childhood malnutrition. The significant differences in growth and body composition between well-nourished and undernourished children highlight the profound impact of malnutrition, reinforcing the need for precise evaluation methods. While the Subjective Global Assessment provides valuable clinical insights, its fair agreement with objective measures suggests that neither method alone is sufficient. Combining the Subjective Global Assessment with objective markers enhances diagnostic accuracy, ensuring the correct identification of at-risk children and enabling more targeted nutritional interventions. This multifaceted strategy is crucial for improving paediatric nutritional care and long-term health outcomes.

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# ANNEXURE

**Subjective Global Assessment**

Name:
Date:

| Medical History | | | A | B | C |
|---|---|---|---|---|---|
| **WEIGHT** | Usual weight..... | Current weight..... | | | |
| **Wt change past 6 months** | Amount weight loss..... | % weight loss..... | | | |
| 0-<5% loss | | | * | | |
| 5-10% loss | | | | * | |
| >10% loss | | | | | * |
| **Weight change past 2 weeks** | | Amount..... | | | |
| No change; normal weight | | | * | | |
| Increase to within 5% | | | * | | |
| Increase (1 level above) | | | * | * | |
| No change, but below usual wt | | | | * | |
| Increase to within 5-10% | | | | * | |
| Decrease | | | | | * |
| **DIETARY INTAKE** | | | | | |
| No change; adequate | | | * | | |
| No change; inadequate | | | | * | |
| **Change** | | **Duration of change**..... | | | |
| Suboptimal diet | | | | * | |
| Full liquid | | | | * | |
| Hypocaloric liquid | | | | | * |
| Starvation | | | | | * |
| Intake borderline; increasing | | | * | | |
| Intake borderline; decreasing | | | | * | |
| Intake poor; no change | | | | * | * |
| Intake poor; increasing | | | | * | |
| Intake poor; decreasing | | | | | * |
| **GASTROINTESTINAL SYMPTOMS** | Frequency (never, daily, no. of times/week) | Duration (<2wk, >2wk) | | | |
| Nausea | ..... | ..... | | | |
| Vomiting | ..... | ..... | | | |
| Diarrhoea | ..... | ..... | | | |
| Anorexia | ..... | ..... | | | |
| None; intermittent | | | * | | |
| Some (daily >2 week) | | | | * | |
| All (daily >2 week) | | | | | * |
| **FUNCTIONAL CAPACITY** | | | | | |
| No dysfunction | | Duration of change ..... | * | | |
| Difficulty with ambulation/normal activities | | | | * | |
| Bed/chair-ridden | | | | | * |
| **Change past 2 week** | | | | | |
| Improved | | | * | | |
| No change | | | | * | |
| Regressed | | | | | * |

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| Physical examination | A | B | C |
|---|---|---|---|
| **SUBCUTANEOUS FAT** | | | |
| Under the eyes | Slightly bulging area | | Hollowed look, depression, dark circles |
| Triceps | Large space between fingers | | Very little space between fingers, or fingers touch |
| Biceps | Large space between fingers | | Very little space between fingers, or fingers touch |
| **MUSCLE WASTING** | | | |
| Temple | Well-defined muscle/flat | Slight depression | Hollowing, depression |
| Clavicle | Not visible in Males; may be visible but not prominent in females | Some protrusion; may not be all the way along | Protruding/prominent bone |
| Shoulder | Rounded | No square look; acromion process may protrude slightly | Square look; bones prominent |
| Scapula/ribs | Bones not prominent; no significant depressions | Mild depressions or bone may show slightly; not all areas | Bones prominent; significant depressions |
| Quadriceps | Well rounded; no depressions | Mild depression | Depression; thin |
| Calf | Well developed | | Thin; no muscle definition |
| Knee | Bones not prominent | | Bones prominent |
| Interosseous muscle between thumb and forefinger | Muscle protrudes; could be flat in females | | Flat or depressed area |
| **OEDEMA** (related to malnutrition) | No sign | Mild to moderate | Severe |
| **ASCITES** (related to malnutrition) | No sign | Mild to moderate | Severe |
| **OVERALL SGA RATING** | **A** | **B** | **C** |

Adapted from: Detsky et al., 1994[8]; Baxter Healthcare Corporation, 1993; McCann, 1996 (Ferguson, Bauer, Banks, Capra, 1996)©

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