

## World Health Organization-Body Mass Index for Age Criteria as a Tool for Prediction of Childhood and Adolescent Morbidity: A Novel Approach in Southern Karnataka, India

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### ABSTRACT

**Background:** Health status of children and adolescents is determined to a larger extent by their nutritional status. There are no published studies available on the influence of thinness on childhood morbidity using new World Health Organization-body mass index (WHO-BMI) for age criteria.

**Methods:** This cross-sectional study was conducted in primary, high schools, pre-university and degree colleges at southern Karnataka for a period of 1 year.

**Results:** Majority 6924 (53.6%) were in the age group of 15-19 years with the mean age of  $14.2 \pm 3.1$  years. 6167 (47.7%) were males and 6749 (52.3%) were females. As per WHO growth standards for children between 5 and 19 years, taking BMI for age criteria into account, 9092 (70.4%) subjects were found to be normal, 3660 (28.3%) thin and 164 (1.3%) overweight/obesity. 8224 (63.7%) subjects were suffering from some sort of morbidities. Mean morbidities rank for subjects with thinness was found to be significantly higher compared with normal and overweight/obese subjects. Thinness was found to be the major predictor of morbidity age, sex and residing in rural areas.

**Conclusions:** Magnitude of thinness among children and adolescents was 28.3%. BMI for age criteria was found to be a significant predictor of childhood and adolescent morbidity.

**Keywords:** Adolescent, body mass index for age criteria, childhood, morbidity, obese, overweight, thinness

### INTRODUCTION

Health of children and adolescents is an urgent public concern and the subject matter of priority in any socio-economic and political conditions, since it determines the future of the country, its intellectual, economic, scientific potential and the nation's gene pool.<sup>[1]</sup> Health status of children and adolescents is determined to a larger extent by their nutritional status. Malnutrition is a silent emergency which is frequently part of a vicious cycle that includes poverty and disease. These three factors are interlinked

in such a way that each contributes to the presence and permanence of the others. Socio-economic and political changes that improve health and nutrition can break the cycle; as can specific nutrition and health interventions.<sup>[2]</sup> About 150 million children in developing countries are still malnourished and more than half of underweight children live in South East Asia Region.<sup>[3]</sup> As per Hunger and Malnutrition, survey conducted across the country in 2009, 42% of children were underweight, even though there was a reduction in the prevalence by 20.3% compared with DLHS survey of 2006, the reduction was not satisfactory.<sup>[4]</sup> The major outcomes of malnutrition during childhood and adolescence may be classified in terms of morbidity, mortality and psychological and intellectual development, low school enrolment, high absenteeism, early drop out, There are also important consequences in adult life in terms of body size, work and reproductive performances and risk of chronic diseases.

The reference previously recommended by World Health Organization (WHO) for children above 5 years of age, i.e. the National Center for Health Statistics (NCHS)/WHO international growth reference, has several drawbacks. In particular, the body mass index (BMI)-for-age reference, developed in 1991, only starts at 9 years of age, group's data annually and covers a limited percentile range. Many countries pointed to the need to have BMI curves that start at 5 years and permit unrestricted calculation of percentile and Z score curves on a continuous age scale from 5 to 19 years. The need to harmonize growth assessment tools conceptually and pragmatically prompted an expert group meeting in January 2006 to evaluate the feasibility of developing a single international growth reference for school aged children and adolescents.<sup>[5]</sup>

Thinness, as per WHO-BMI for age criteria is the condition where the Z scores for BMI for age fall below 2 standard deviation (SD) of normal values. Thinness can be used as a proxy indicator for under nutrition as defined by weight for age criteria, which has a limited value among adolescents. Thinness acts as a predisposing factor for morbidities which intern trigger thinness. This arouses an interest to assess the degree to which the thinness predicts morbidities among children and adolescents. In this background, the present study

was undertaken to assess whether the WHO BMI for age criteria can be utilized as a tool to predict morbidity among school children and adolescents between 5 and 19 years.

## METHODS

This cross-sectional study was conducted in the primary, secondary schools, pre-university and degree colleges under JSS Mahavidyapeetha school health initiative in both urban and rural areas over a period of 1 year. JSS Mahavidyapeetha school health initiative was started in the year 1996 which has the aim of providing health appraisal services to 51 schools (primary + secondary), 5 pre-university colleges and 3 degree colleges distributed across Mysore, Mandya, Chamarajanagar and Hassan districts of Karnataka four constituting around 16,000 students. Most of these schools and colleges are from the private sector and received an annual grant aid from state government. A letter to seek permission to participate in the school health appraisal was sent to these schools school and colleges. Some of adolescents in the age group of 18 and 19 years would be expected to study in first and few in 2<sup>nd</sup> year of degree so as to fulfill the age criteria of 5-19 years degree colleges were also included. A total of 41 schools and 3 pre-university and two degree colleges agreed to participate in the study. Others expressed their inability to organize the health appraisal due to the co-incidence of health check-up schedule with examination dates and holidays thus they were excluded. Approval from Institutional Ethical Committee was obtained before initiation of the study. All the students satisfying the age limit and studying in these schools and colleges were included in the study. The students who were absent on the day of the visit were revisited on three subsequent occasions before excluding them. Details regarding general characteristics such as age, sex, class in which the student is studying, locality were collected in structured school health cards from the respective class teachers in which students are studying. In pre-university and degree colleges, the general characteristics were collected from students by interview technique. As the study was a part of school health program (SHP) and possessed no invasive interventions thus group consent by the class teachers and school/college authorities was

considered sufficient. In case of any serious illness was detected, parents of the child/adolescent was called to the school/college and details were explained and motivated to go for further evaluation in our own tertiary care hospital. These referrals were also followed-up by post-graduates and faculty.

### Anthropometry

Each child's height and weight were measured in the metric system, using standardized techniques. A stadiometer (measuring rod) capable of measuring to accuracy of 0.1 cm was used to assess height of the subjects. The subject was made to stand without footwear with the feet parallel and with heels, buttocks, shoulders and occiput touching the measuring rod, hands hanging by the sides. The head was held comfortably upright with the top of the head making firm contact with the horizontal head piece. A portable balance with accuracy of 100 g was used to record the weight of the subjects. Children were instructed to stand on the balance with light clothing and without footwear and with feet apart and looking straight. Weight was recorded to the nearest value.

### Morbidity pattern

All the medical interns, interns who were involved in the SHP were given 1 day basic training on the following aspects:

- Objectives of SHP
- Components of school health appraisal
- Anthropometry
- Common morbidities among school children
- Clinical features of common morbidities such as respiratory tract infections, refractive errors, skin diseases, dental morbidities and anemia were explained with the help of audio-visual aids and pictures by a team of Assistant Professors and Professors of Community Medicine who are involved in SHP since last 5 years.
- Interns were distributed a school health appraisal guide developed by the Department which had brief description and pictures of various common childhood morbidities to aid them for easier diagnosis. Morbidities were broadly categorized into those related to the scalp and hair, skin, eyes, ear, nose and throat (ENT), oral cavity, respiratory system, cardiovascular system, gastro intestinal system, central nervous system.

- I. Diseases of the scalp and hair:
  - Seborrhea capitis (dandruff): Presence, in varying amounts, of white or gray scales in the hair of the scalp
  - Alopecia areata or totalis: Patchy loss and total loss of hairs of hair on scalp
  - Unhealthy texture of hairs.
- II. Diseases of the skin:
  - Pityriasis alba: Presence of ill-defined, scaly, faintly erythematous patches especially on the face
  - Scabies: Presence of itchy, thin, irregular burrowing lesions made of tiny blisters and bumps on the skin especially, in web spaces, arm pits, waist, inside of wrist etc
  - Pyoderma: Any purulent lesions on the skin that may include, furuncle, pustule, impetigo, boil etc
  - Contact dermatitis: Inflammatory lesions on the skin coming in contact with external substances such as, soap, cosmetics, mud/cement, watch, bindi (Kumkum), stickers etc., characterized by, red, crusty, scaly, itchy patches
  - Photo-dermatitis: Presence of superficial, reddish, itchy, raised lesions on sun exposed part of the body
  - Acne: An eruption, predominantly of the face, upper back and chest, composed of comedones, cysts, papules and pustules on an inflammatory base
  - Urticaria: A transient appearance of slightly elevated patches (wheals) which are redder or paler than the surrounding skin and often attended by severe itching.
- III. Pallor: Paleness of either, palpebral conjunctiva, palm/soles, dorsum of tongue or all of them, suggestive of anemia.
- IV. Diseases of eyes:
  - Refractive error: Visual acuity of 6/9 or less as per Snellen's chart with improvement by pinhole test was considered refractive error
  - Conjunctivitis: Acute onset reddish coloration of one or both the eyes associated with watering, pain, itching and thick discharge
  - Xerosis of conjunctiva: Dry, lusterless bulbar conjunctiva
  - Bitot spots: Gray, triangular spots on the conjunctiva

- Acute dacryocystitis: Pain, redness, tearing and swelling at the inner corner of the eye by the nose.

V. Diseases of ENT:

- Acute suppurative otitis media: Acute onset ear pain, typically presenting as pain deep inside the ear canal, with mild hearing impairment, pain subsiding after initiating of ear discharge usually associated with systemic symptoms of fever, malaise, fatigability
- Chronic suppurative otitis media: Chronic inflammation of the middle ear and mastoid cavity, which presents with recurrent ear discharge, hearing impairment usually lasting for more than 2 weeks (WHO)
- Acute respiratory infection (ARI): Children with any one or combinations of symptoms and signs such as cough and cold, running or blocked nose, sore throat, rapid breathing, noisy breathing, stops feeding and or drinking, chest in drawing etc., A new episode was taken as one occurring in an individual who had been free of symptoms for at least 3 consecutive days or more as per WHO (1997) definition of ARI.
- Acute tonsillitis: Bilaterally red and enlarged tonsils with purulent discharge and yellowish membrane on the surface of tonsils associated with fever, pain or difficulty while swallowing
- Acute sinusitis: Pain, tenderness, swelling and pressure around eyes, cheeks, nose or forehead associated with headache, fever and other features of systemic inflammation
- Deviated nasal septum: Deviation of the nasal septum with narrowing and congestion of opposite nasal cavity
- Similar way other conditions such as epistaxis, external abnormalities were also defined.

VI. Diseases of the oral cavity:

- Gingivitis, cheilitis, glossitis, angular stomatitis: Swelling and reddishness of gums, lips, angles of mouth and tongue
- Dental caries and impacted teeth were diagnosed based on the observations.

VII. Respiratory tract:

- Lower respiratory tract infection: History of cough, fever, rapid breathing, noisy breathing, stops feeding and or drinking,

chest in drawing etc., A new episode was taken as one occurring in an individual who had been free of symptoms for at least 3 consecutive days or more

- Bronchial asthma: History of cough, recurrent episodes of breathlessness, wheezes, with bilateral widespread rhonchi all over lung fields.

VIII. Diseases of the cardiovascular system: A child with history of chest pain on exertion, exercise intolerance, breathlessness on exertion with murmurs in any of the four areas of pre-cardium.

IX. Diseases of Gastro intestinal system: History of abdominal pain, nausea, vomiting, loose stools, pus/blood in stools, with epigastric tenderness, hepatomegaly and splenomegaly on examination.

X. Diseases of Genitourinary tract:

- Dysmenorrhea: Abdominal pain of spasmodic type during perimenstrual or menstrual period
- Urinary tract infection: History of fever, burning micturition and vomiting, increased frequency of micturition.

XI. Diseases of Central Nervous System: History of unilateral headache with vomiting, convulsions, mental retardation, speech deformities, paralysis of any of the limbs.

- Treatment options

A school health team was constituted which has one Assistant Professor with MD in Community Medicine, one Medico Social Worker; two post graduate students in Community Medicine, 10 interns and one attender. The responsibility of the faculty member in the team was to provide timely supportive supervision and validation of diagnosis done by the interns. Finally number of morbidities under each system were counted and tabulated. Children suffering from acute infections were treated with relevant drugs at the spot of detection and those in need of specialized care were referred to the higher centers.

### Statistical analysis

Data collected in school health cards were entered in Microsoft Excel-2007 (Microsoft Excel. Redmond, Washington, USA) and analyzed using SPSS-18.0 version (SPSS Inc. Released 2009. PASW



Statistics for Windows, Chicago, USA). Descriptive statistical measures such as percentage, mean, SD were applied. BMI derived was categorized by using Z score tables of WHO-BMI for age standards for children and adolescents between 5 and 19 years. Subjects with morbidities were given scores depending on the number of morbidities they had. Kruskal Wallis test was applied to test the difference in mean ranks of scores between children with normal nutritional status, thinness and overweight/obesity. Binary logistic regression analysis was applied for ascertaining various predictors of childhood morbidity. The differences were considered to be statistically significant at  $P < 0.05$ .

## RESULTS

### General characteristics

Among 12,916 subjects enrolled in the study, 9360 (72.5%) were from urban and 3556 (27.5%) were from rural areas. Majority 6924 (53.6%) were in the age group of 15-19 years with the mean age of  $14.2 \pm 3.1$  years. 6167 (47.7%) were males and 6749 (52.3%) were females, 7950 (61.5%), 2122 (16.4%), 2844 (22.1%) were studying in schools, pre-university colleges and degree colleges respectively.

### Nutritional status

As per WHO growth standards for children between 5 and 19 years, taking BMI for age criteria into account, 9092 (70.4%) subjects were found to be normal, 3660 (28.3%) thin and 164 (1.3%) overweight/obesity [Table 1]. Thinness (Z score  $< -2SD$ ) was found to be highest in the age group of 10-14 years 1379 (32.4%), males 2241 (36.3%), school children 2529 (31.8%) residents of rural areas 1454 (40.9%). On the other hand overweight/obesity (Z score  $> 2SD$ ) was found to be highest in the age group of 5-9 years 54 (3.1%), males 94 (1.5%), school children 117 (1.5%) and urban areas 127 (1.4%) [Table 2].

### Morbidity pattern

Among 12,916 subjects, overall prevalence of one or more morbidities were 8224 (63.7%). There was a statistically significant association between overall prevalence of morbidities and thinness. Coming to individual system wise morbidities, diseases of skin, oral cavities, eyes, pallor, ENT,

**Table 1:** Distribution of study subjects based on their nutritional status as per BMI for age criteria

BMI for age category	Number	Percentage
Normal	9092	70.4
Thin	3660	28.3
Overweight/obesity	164	1.3
Total	12,916	100.0

BMI=Body mass index

gento-urinary system and central nervous system were significantly higher among subjects with thinness compared with those who had normal and overweight/obese categories [Table 3].

### BMI for age as a predictor of morbidity

Each subject was given with one point score for each of the morbidities he/she had and total score for individual subject were calculated. Subjects having no morbidities scored zero and those who had the maximum number of morbidities scored eight. These scores were tested using Kruskal Wallis test between normal, thin and overweight/obese subjects. Mean morbidities rank for subjects with thinness was found to be significantly higher (7024.20) compared to normal (6234.25) and overweight/obese (6266.04) ( $\chi^2 = 145.8$ ,  $P = 0.001$ ) [Table 4]. Binary logistic regression analysis showed that, thinness as a major predictor of morbidity (odds ratio: 2.158,  $P = 0.001$ ) compared to age, sex, residing in rural areas [Table 5].

## DISCUSSION

The health and nutritional status of children and adolescents is an index of national investment in the development of its future manpower. Childhood and Adolescence is a significant period of human growth and maturation. Morbidities in this period can hinder their growth and development and causing serious damage to their scholastic and vocational performances. Various attempts were made to generate universal criteria for classifying the nutritional status of children and adolescents. WHO-BMI for age is one such criterion which brings children and adolescents under one umbrella and uniformly classifies them into normal, underweight and overweight/obesity using Z scores. This study tries to make a novel attempt in finding whether this classification can predict morbidity among children and adolescents.

**Table 2:** Distribution of study subjects based on socio-demographic characteristics

Character	BMI category			Total	P
	Normal	Thin	Overweight/obesity		
Age					
5-9	1393 (80.1)	292 (16.8)	54 (3.1)	1739 (13.5)	0.001
10-14	2822 (66.4)	1379 (32.4)	52 (1.2)	4253 (32.9)	
15-19	4877 (70.4)	1989 (28.7)	58 (0.8)	6924 (53.6)	
Sex					
Male	3832 (62.1)	2241 (36.3)	94 (1.5)	6167 (47.7)	0.001
Female	5260 (77.9)	1419 (21.0)	70 (1.0)	6749 (52.3)	
Locality					
Urban	7027 (75.1)	2206 (23.6)	127 (1.4)	9360 (72.5)	0.001
Rural	2065 (58.1)	1454 (40.9)	37 (1.0)	3556 (27.5)	
Category					
School	5304 (66.7)	2529 (31.8)	117 (1.5)	7950 (61.5)	0.001
Pre-university	1524 (71.8)	584 (27.5)	14 (0.6)	2122 (16.4)	
Degree college	2264 (79.6)	547 (19.2)	33 (1.2)	2844 (22.1)	

Figures in parenthesis indicate percentages, Chi-square test

**Table 3:** Distribution of study subjects based on their morbidity profile

Morbidities	Normal (9092)	Thin (3660)	Overweight/obesity (164)	Total=12,916	P
Scalp and hair	243 (2.7)	102 (2.8)	2 (1.2)	347 (2.7)	0.473
Skin	923 (10.2)	316 (8.6)	12 (7.3)	1250 (9.7)	0.019
Pallor	1021 (11.2)	655 (17.9)	13 (7.9)	1689 (13.1)	0.001
Eyes	1015 (11.2)	706 (19.3)	7 (4.3)	1728 (13.4)	0.001
Ear, nose and throat	909 (10.0)	508 (13.9)	9 (5.5)	1426 (11.0)	0.001
Oral cavity	601 (6.6)	327 (8.9)	8 (4.9)	936 (7.2)	0.001
Respiratory system	28 (0.3)	10 (0.3)	2 (1.2)	40 (0.3)	0.103
Cardiovascular system	25 (0.3)	9 (0.2)	1 (0.6)	35 (0.3)	0.682
Gastro intestinal system	56 (0.6)	27 (0.7)	2 (1.2)	85 (0.7)	0.498
Genitourinary system	231 (2.5)	162 (4.4)	5 (3.0)	398 (3.1)	0.001
Central nervous system	181 (2.0)	108 (3.0)	0	289 (2.2)	0.001
Total	5058 (57.6)	2877 (80.1)	289 (37.2)	8224 (63.7)	0.001

Figures in parenthesis indicate percentages, Chi-square/Fisher's exact test

In the present study, it was observed that 28.3% of subjects were having thinness (BMI for age  $< -2SD$ ). This is in contrast to the findings of a study conducted by Bhoite and Iyer.<sup>[6]</sup> at Vadodara, where 56.9% children were having thinness and in line with the observations of Deb *et al.*<sup>[7]</sup> in Kolkata, where 34.3% children were having BMI less than  $-2SD$  of normal. Anand *et al.*<sup>[8]</sup> in a study at Delhi noted that 43.8% of boys and 30.1% of girls had thinness. The probable reasons for lower magnitude of thinness in the present study could be all the studies mentioned above were among either school children or adolescents but here a wide range of subjects from 5 to 19 years are

covered. It is also documented that WHO BMI for age is known for underestimating under nutrition and thinness compared with Centers for Disease Control and NCHS criteria.

In the present study 63.7% were found to have morbidities. This is similar to the findings of Deb *et al.*<sup>[7]</sup> at Kolkata where 76% of boys and 74% of girls had morbidities. Yang *et al.*<sup>[9]</sup> also noted that 79.5% of students had at least one health problem and on average, each student had 1.6 health problems. On the other hand Damhare *et al.*<sup>[10]</sup> at Wardha noted that 86.21% adolescents were suffering from one or more illness at the time of examination. Jyothi Lakshmi *et al.*<sup>[11]</sup> at Mysore

**Table 4:** Comparison of morbidity scores among subjects under different categories of BMI for age

BMI for age category	N	Mean rank	$\chi^2$	P
Normal	9092	6234.25	145.8	0.001
Thin	3660	7024.20		
Overweight/obesity	164	6266.04		

Kruskal Wallis test. BMI=Body mass index

**Table 5:** Predictors of morbidity status among study subjects

Variable	P	OR	95% CI for OR	
			Lower	Upper
Locality	0.235	1.051	0.969	1.139
Age (years)	0.000			
10-14	0.000	0.697	0.623	0.779
15-19	0.454	1.031	0.952	1.117
Sex	0.001	0.695	0.646	0.747
BMI cat	0.022			
BMI (thin)	0.002	2.158	1.138	3.601
BMI (overweight/obese)	0.830	1.035	0.753	1.425
Constant	0.372	0.862		

Binary logistic regression analysis. Reference categories- Age: 5-9 years, Sex: Male, Locality: Urban. BMI: Normal. BMI=Body mass index, OR=Odds ratio, CI=Confidence interval

observed that at any point of time in a year, nearly (49%) of the children were found to be sick. The higher burden of morbidities in the present study may be attributed to negligence and lack of availability of health services to the children and adolescents. More over thinness as revealed by low BMI for age is also a significant contributor for higher burden of morbidities.

Common morbidities among males in the present study were related to skin, ENT, oral cavity and those among females were related to hairs, eyes, pallor and genitourinary system, Ananthkrishnan *et al.*<sup>[12]</sup> Pondicherry, Taiwan *et al.*,<sup>[9]</sup> Dambhare *et al.* at Wardha,<sup>[10]</sup> Bhandari and Shrestha<sup>[13]</sup> and Shakya *et al.*<sup>[14]</sup> at Nepal also made similar observations.

The present study has observed significantly higher morbidity scores among subjects with thinness compared to that of subjects normal and overweight/obesity. Thinness also scored highest odds ratio among all other anthropometric parameters. Even though various studies in literature have tried to explore the association between malnutrition and morbidities, no published studies are available on

using WHO - BMI for age criteria with magnitude of morbidities. The above mentioned criteria is often criticized for the reason that this under estimates under nutrition. Even in spite of this, the data from present study could prove it beyond doubt that thinness acts as a strong predictor of morbidities among children and adolescents.

## CONCLUSIONS

In the present study magnitude of thinness among children and adolescents was found to be 28.3%. Nearly 63.7% of subjects were suffering from one or more than one morbidities. Morbidity scores were significantly higher among subjects who were having BMI for age less than -2SD and it scored highest odds ratio for predicting morbidity.

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