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Dual Burden of Weight among College Entrants at Kancheepuram, Tamil Nadu

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ABSTRACT

Background: Body Mass Index (BMI) is a good indicator of health and well-being. Even though it does not accurately measure body fat, BMI is advocated as a simple instrument for identifying obesity. Obesity is a global public health problem with ever-increasing incidence. The data on the regional distribution of BMI, an index of health will be useful in the case of healthcare policy formulation. This study aimed to provide data about the frequency distribution of BMI among adolescents and young adults in Kancheepuram, Tamil Nadu, India.
Subjects and Method: This was a cross-sectional study conducted at Kancheepuram, Tamil Nadu, in September 2023. A total of 1,050 college students was selected using convenience sampling. The dependent variable was BMI. The independent variables were age and sex. The classification of BMI was based on Asian Indian criteria, supplemented by WHO guidelines..
Results: Obesity among males was 2.93% according to WHO criteria and 9.56% according to the Asian Indian modification, while for females, obesity was 3.03% by WHO criteria and 10.98% by the Asian Indian modification. Based on Asian Indian criteria, 27.90% of the sample was classified as underweight, 8.85% as overweight, and 20.66% as obese.
Conclusion: The problem of overweight and obesity needs public health attention since this is preventable.

Keywords: thinness, obesity, body mass index

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BACKGROUND

Body mass index (BMI) is defined by WHO (2021) as a person's weight in kilograms divided by the square of his height in meters (kg/m2). BMI is weight in kilograms per square of height in meters. BMI is a simple index of weight for height that is commonly used to classify overweight and obesity in adults. It is a commonly used, simple bedside measure of obesity. For children and adolescents WHO child growth percentile charts are available. It is a good index in epi-

demiological studies to classify the population or individual as normal weight, underweight, overweight, or obese. BMI does not differentiate weight associated with muscle and fat. In the case of athletes and muscular people, its value is doubtful. BMI also does not represent body fat distribution. WHO states BMI provides the most useful population-level measure of overweight and obesity as it is the same for both sexes and all ages of adults. BMI can be used as a population screening test (WHO, 2021).

BMI identifies two important groups of the population namely obese and underweight. These two groups have implications on the well-being or in other words morbidity and mortality of the individual or society. Obesity has increased nearly threefold since 1975 globally. Obesity is a global public health problem. It is a pandemic of this century. Obesity is a risk factor for diabetes mellitus, cardiovascular diseases, dyslipidemia degenerative joint diseases, fatty liver, and cancers like adenocarcinoma esophagus, pancreatic cancer, and colorectal cancer. On the other hand, undernutrition is associated with a high rate of infection, poor immune status, and increased morbidity and mortality. Developing countries like India are faced with under-nutrition on the one hand and rising obesity on the other hand jeopardizing the socio-economic status. There is a heavy tool on human life, loss of productivity, and a heavy burden on health care spending. BMI is recognized as a significant indicator of health and well being that Kirk suggested BMI be considered a vital sign (Kirk et al., 2009). Ruggieri and Bass (2015) recommended BMI as a screening and surveillance tool for obesity in school health programs as a preventive measure of childhood obesity.

WHO recommended cut-off points for defining obesity. BMI less than 18.49 kg/m2 indicates underweight, 18.5 to 24.9 as normal weight, 25 to 29.9 as overweight, and more than 30 as obese. Later in 2004, WHO expert consultation concluded that a proportion of the Asian population developed cardiometabolic complications at BMIs lower than its earlier universal recommendations, but did not redefine cut-off points for each population separately (WHO Expert Consultation, 2004). A consensus statement by Indian experts in this regard was published in 2009 and its recommendation is BMI less than 17.9 kg/m2 as underweight, 18-22.9 as normal, 23 t 24.9 as overweight, and more than 25 as obese (IIPS, 2021; Misra et al., 2009). Amidst divergent context, we are presenting our data since we do not have any such data in our region. This study aimed to provide data on BMI distribution at Kancheepuram, Tamil Nadu, India.

SUBJECTS AND METHOD

1. Study Design

This was adescriptive epidemiological cross-sectional study was conducted at Kancheepuram, Tamil Nadu, in September 2023.

2. Population and Sample

The target population was adolescents and young adults. The study population was college entrants of a university situated at Kancheepuram. A “convenience sampling” method was utilized to select the participants based on their availability and willingness to participate in the study. The data were collected in September 2023. A total of 1050 samples were selected using convenience sampling. Kanchipuram, an ancient city of historic importance is a semi-urban, multi-ethnic town situated 70 km southwest of Chennai, Tamil Nadu, with a population of 3,998,252 (Census of India, 2014). The average literacy rate is 84.49%. Most of the population belongs to Class III to IV of the modified Kuppuswamy Socio-Economic Scale. The majority of the study population

belonged to Class II of the modified Kuppuswamy Socio-Economic Scale. They were mainly from neighboring areas and about 28 % were from different states of India.

3. Study Variables

The primary end of this study was to determine the distribution of BMI among the target population. The gender and age were the variables considered.

4. Operational Definition of Variables

BMI: is calculated as weight in kilograms divided by height in square metre-kg/m2. BMI was analyzed mainly as per Asian Indians Criteria and comparative analysis was done as per WHO criteria also.

5. Study Instruments

Data were collected as per a structured proforma. The measurement was done by a single observer (SK). The weight was measured with an electronic weighing machine (Samso - India). The height was measured by measuring tape (Bio-plus, India) and corrected to the nearest round number. The participants wore lightweight formal dress weighing roughly 400 to 500 gms.

6. Data Analysis

Data were anonymized and analyzed. The Microsoft Excel sheet was used. Simple statistical methods i.e., average, proportion, and percentage were employed in analysing the data.

7. Research Ethics

Data were collected only from the willing participants. Before the collection of data, the participants attended the sensitization meeting and they were informed well of the study, especially anonymity and confidentiality. They were convinced about the aims and cooperated well. This was only an analysis of data and no intervention was carried out, Hence the ethical clearance was waived.

RESULTS

There were 1,050 subjects in total with 594 (56.7%) males and 456 (43.4%) females. The age varied from 17 to 21 years. The mean age was 18.52+/-1.06 years. The median and mode were 19 years. BMI varied from 12.49 to 47.06; Mean BMI was (Mean= 21.23; SD= 4.87), median BMI was 20.22, and mode BMI was 18.91. The BMI of all subjects was classified according to Asian Indian modification.

Table 1. Sample Characteristics - burden of weight among college entrants at Kancheepuram, Tamil Nadu (N= 1,050)

Characteristic	Category	Frequency (n)	Percentage (%)
Age	17 years	206	19.61
	18 years	311	29.61
	19 years	338	32.19
	20 years	164	15.61
	21 years	31	2.952
Gender	Male	594	56.57
	Female	456	43.42
BMI (kg/m^2)	Underweight (<17.9 kg/m^2)	293	27.90
	Normal (18 – 22.9)	447	42.57
	Overweight (23 – 24.9)	93	8.85
	Obese (>25)	217	20.66

The characteristics of the study population are given in Table 1. 19.61% were aged 17 years, 29.61 were 18 years, 32.19% were 19 years, 15.61 % were 20 years and 2.952%

were 21 years. The median age was 19 years. Only a small proportion (2.952%) were 21 years. The study population was mainly the adolescent group. Gender-wise 56.57% were males and 43.42% were females and there was no gross gender inequity. The distribution of the study population by BMI was 42.57% normal weight, 8.85% overweight, 27.90% underweight, and 20.66% obese. The Asian modification of WHO criteria applied.

Table 2. BMI distribution of study population by WHO and Asian Indians criteria (N=1,050)

Parameter	WHO criteria (kg/m²)			Asian Indians criteria (kg/m²)		
	Criteria	n	%	Criteria	n	%
Underweight	<18.49	352	33.5%	<17.9	293	27.9%
Normal weight	18.5 to 24.9	481	45.8%	18 to 22.9	447	42.5%
Overweight	25 to 29.9	154	14.6%	23 to 24.9	93	8.8%
Obese	>30	63	6.0%	>25	217	20.6%

The WHO universal criteria and Asian Indian modification criteria of BMI of the study group were compared and given in Table 2. As per WHO criteria, 33.5% were underweight, 45.8% were normal weight, 14.6% were overweight and 6% were obese. As per Asian modification of WHO criteria, 27.9% were underweight, 42.5% normal weight, 8.8% overweight and 20.6% obese.

Table 3. Gender-wise distribution of BMI by WHO and Asian Indians criteria (N= 1,050)

Gender	Criteria	I Underweight		II Normal weight		III Overweight		IV Obese	
		n	%	n	%	n	%	n	%
Male	WHO	212	20.19	281	26.76	70	6.66	31	2.93
	Asian Indians	180	17.04	264	25.14	49	4.64	101	9.56
Female	WHO	140	13.33	200	19.04	84	8.00	32	3.03
	Asian Indians	113	10.76	183	17.42	44	4.16	116	10.98

The gender-wise distribution of BMI by WHO and Asian Indian criteria was analyzed and results were given in Table 3. Among the males 20.19% were underweight, 26.76% were normal weight, 6.66% were overweight and 2.93% were obese as per WHO criteria and 17.04% were underweight, 25.14% normal weight, 4.64% were overweight and 9.56% were obese as per Asian modification. Among females, 13.33% were underweight, 19.04 normal weight, 8% were overweight, 3.03% were obese as per WHO criteria 10.76% were underweight, 17.42% were normal, 4.16% were overweight and 10.98% were obese as per Asian modification criteria. The females were at risk of obesity i.e. 10.98% as per Asian modification of WHO criteria.

Table 4. Age-wise distribution of the BMI by WHO and Asian Indians criteria

Age	Criteria	I Underweight		II Normal weight		III Overweight		IV Obese	
		n	%	n	%	n	%	n	%
17	WHO	82	7.76	79	7.52	32	3.03	13	1.23
	Asian Indians	74	7.00	74	7.00	13	1.23	45	4.26
18	WHO	112	10.6	143	13.5	39	3.69	17	1.6
	Asian Indians	90	8.52	137	12.97	28	2.65	56	5.3
19	WHO	112	10.6	159	15.05	46	4.35	21	1.98
	Asian Indians	96	9.09	142	13.44	33	3.125	67	6.34
20	WHO	39	3.69	81	7.67	32	3.03	12	1.13
	Asian Indians	26	2.46	77	7.29	17	1.60	44	4.16
21	WHO	7	0.66	19	1.79	5	0.473	0	0.00
	Asian Indians	7	0.66	17	1.60	2	0.18	5	0.47

The age-wise distribution of BMI is given in Table 4. As per WHO criteria 7.52% of 17 years age, 13.5% of 18 years age, 15.05% of 19 years age, 7.67% of 20 years age and 1.79% of 21 years age had normal weight. The corresponding values as per Asian modification were 7% for 17 years, 12.97% for 18 years, 13.44% for 19 years, 7.29% for 20 years, and 1.60% for 21 years. The values for underweight as per WHO criteria were 7.76% for 17 years of age, 10.6% for 18 years and 19 years of age, 3.69% for 20 years of age, and 0.66% for 21 years of age. The corresponding values for underweight as per Asian modification were 7.00% for 17 years, 8.52% for 18 years, 9.09% for 19 years, 2.46% for 20 years, and 0.662% for 21 years. Overweight as per WHO criteria was seen among 3.03% of 17 years, 3.69% of 18 years, 4.35% of 19 years, 3.03% of 20 years, and 0.47% of 21 years, and obesity among 1.23% of 17 years, 1.6% of 18 years, 1.98% of 19 years, 1.13% of 20 years and none of 21 years age. As per Asian modification criteria, overweight observed among 1.23% of 17 years, 2.65% of 18 years, 3.125% of 19 years, 1.6% of 20 years, 0.473% of 21 years, and obesity among 4.26% of 17 years, 5.3% of 18 years, 6.34% of 19 years, 4.16% of 20 years and 0.473% of 21 years age. The cells in the 21-year-old age group contain numbers less than 5 and hence statistical significance was not considered.

DISCUSSION

Only the most important observations noted in this study will be discussed. As per WHO criteria, the prevalence of obesity, overweight, and underweight in this study were 6%, 14.66%, and 33.52% respectively. As per Asian Indian modification, the prevalence of obesity, overweight and underweight was 20.6%, 8.8%, and 27.9% respectively. Only 45% of this study population had normal weight. The prevalence of underweight and obesity is significantly high. The double burden faced by developing countries is evident. The age group of our study population was 17 to 21 years. This is a transit period from young adolescent to adult and can have physiological implications. Realizing the importance in 2016, WHO declared "Ending all forms of malnutrition is the global goal". The statement from WHO is reproduced here. "The double burden of malnutrition is characterized by the coexis-

tence of undernutrition along with overweight, obesity or diet-related NCDs, (Non-Communicable Diseases) within individuals, households and population, and across the life course." In developing countries (Low and Middle Income Groups) double burden of malnutrition shows an increasing trend.

The NFHS-5 (National Family Health Survey-5) data was also alarming (IIPS, 2021). It reported women whose BMI is below 18.5 kg/m2 as 12.6%, women whose BMI was overweight or obese (> 25 kg/m2) as 46.4%, and women who have a high-risk Waist: Hip: Waist ratio (WHR >0.85) as 48.9%. The dual burden of malnutrition has been well recognized globally. The prevalence of the dual burden of malnutrition in developing countries and the changing trend over the past few decades is alarming. In India, we have data from National Family Health Survey (NFHS) giving insights into this public health problem. There are four articles available that are based on NFHS – IV (2015 – 2016) and we discuss them here. Al-Kibria et al. (2019) reported the prevalence of undernutrition at 22.9%, overweight at 22.6%, and obesity as 10.7% among women of reproductive age from the NFHS – IV database. They also found out the risk for underweight was higher among young, nulliparous, contraceptive non-users, never married, Hindu, backward caste, less educated, less wealthy, and rural women. The risk for overweight and obesity was higher among women who were older, ever pregnant, ever married, Muslims, castes other than backward, highly educated, wealthy, and living in urban regions. Dutta et al. (2019) conducted stratified two-stage sampling of the NFHS – IV database and reported the distribution of underweight and overweight/obesity among different geographical areas in India. The underweight was prevalent in the central and western regions of India. The smoking and use of smokeless tobacco were found to be a risk for underweight. The overweight was prevalent in urban areas, southern and northern regions, and among adults aged 35 to 49 years. The level of education and wealth index is positively associated with overweight and obesity.

Bhandari (2021) analyzing data from 108,092 males and 642,002 females from the NFHS – IV database reported a prevalence of underweight in males at 19.7%, in females at 22.9%, overweight in males at 19.6% and in females at 20.6%. The burden of underweight showed a downward trend. There was a clustering of underweight and obesity in specific geographical areas. The underweight was prevalent in districts from central, western, and eastern regions and obesity was prevalent in southern and northern regions. Gao et al. (2020) reported the double burden of malnutrition among preschool children and childbearing women from four countries that are China, India, Pakistan, and Nepal. They analyzed large-scale national data available from the respective countries and NFHS–IV was one among them. They concluded that nutritional status and health burden were heavily influenced by economic development. China ranking highest in economic development showed the highest prevalence (11.9%) of overweight/obesity. India though placed above Pakisthan and Nepal in economic development showed 38.4% of stunting, 21.0% of wasting, and 35.7% of underweight. The data from Pakistan showed the highest prevalence of overweight/obesity among childbearing women i.e. 52.4% in all and 63.0% in urban areas. Nepal ranked as lowest in economic development showed overweight/obese preschool children prevalence of 1.2%. China had the highest overweight and obesity to underweight ratio (4.60) whereas the ratio in Nepal was the lowest (0.04).

Little et al. (2016) studied the double problem of malnutrition in a South-Indian village (rural) between 2013 and 2014 among adults 20 to 80 years of age. They reported a prevalence of underweight at 22.7%, overweight at 14.9%, grade I obesity at 16.1%, and grade II obesity at 3.3%. The variables associated with high BMI were low physical activities, high wealth index, no livestock, low animal fat consumption, high n-6-polyunsaturated fat (PUFA) consumption, television ownership, time spent watching television, low rurality index, and high caste. The variables for underweight risk were low wealth index, high rurality index, and low intake of n-6-PUFA. This study enlightened the various socioeconomic and nutritional variables influencing the dual burden of malnutrition. Kumar et al. (2020) reported an analysis of 211 women 18 years old and above who resided in a resettlement area, in the Kancheepuram district. The underweight was noted in 1.4%, overweight in 12.8%, pre-obesity in 48.8%, and grade I obesity in 19.95% as per BMI. The same study population showed 23.7% were at risk of abdominal obesity by waist circumference and 69.7% were at risk of obesity by Waist: Hip Ratio measurement. Diabetes mellitus was prevalent (80.3%) in those whose Waist: Hip Ratio was high. The rates of overweight showed an increase surpassing the rate of underweight.

The causes of the double burden are related to WHO to a sequence of epidemiological changes known as the nutrition transition, the epidemiological transition, and the demographic transition. From the viewpoint of further action WHO insists on “double-duty action”. The health care policy and execution should aim at 1. to reduce simultaneously the risk or burden of both undernutrition (including wasting, stunting, and micronutrient deficiency or insufficiency) and 2. Overweight, obesity, or diet-related NCDs. The intervention should start at the antenatal period and continue into the life course. Health education should aim at modifying life and behavioral changes. Access to a healthy and sustainable diet from an appropriate and resilient food system should be ensured (WHO, 2017)

Asian Indian's criteria seem to be appropriate in our context. In this study as per WHO criteria, there is an underestimation of obesity. It is accepted that cardiometabolic complications occur at lower BMIs in Asian Indians. But controversy surrounds this topic. There are few studies stating that there is no need for separate criteria for Asian Indians. Deepa Vasudevan and others concluded in their study that WHO and NCEP-ATP III (National Cholesterol Education Programme – Adult Treatment Panel III) criteria under-diagnosed overweight and obesity in a South Asian descent population and suggest that modified criteria will be more appropriate (Vasudevan et al., 2011).

Analyzing gender-wise data, the obesity and overweight among males were 2.9%. 6.6% as per WHO criteria and 9.5% and 4.6% as per Asian Indians Modification. Similar data for females were 3.0% and 8 as per WHO criteria and 10.9% and 4.16% as per Asian Indians modification. The females were at risk of obesity and overweight. The study population included subjects aged between 17 and 21 years and they were from various states of India. This may not represent a general population. Hence generalization of observation of this study is subject to criticism. Due to certain difficulties, we were unable to include more variables like diet, lifestyle patterns, and socioeconomic status. These are the limitations of our study.

This study found the double burden of being underweight and obese among the adolescent and young adult population at

Kancheepuram, Tamil Nadu, India. Our prevalence of underweight is 33.5% and obesity is 27.9%. There is a need for public health attention on this non-communicable disease. The present public health approach aiming only at malnutrition (underweight) needs to be changed to an approach aimed at the dual burden of weight. The Asian Indian criteria need critical evaluation and wider application in our context.

AUTHOR CONTRIBUTION

S Keerthana collected and tabulated the data at the field level. Padmanaban P and N Dinakaran formed the concept and wrote and revised the manuscript. Somnath V and Bhavishya S contributed to the collection of the reference and proofreading.

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CONFLICT OF INTEREST

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