International Journal of Research in Medical Sciences
Sethi J et al. Int J Res Med Sci. 2026 Dec;14(12):5807-5811
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20264487

Original Research Article

Somatotype stratification by gender and body mass index among health science students in Northern India

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Received: 01 October 2026
Accepted: 06 November 2026

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ABSTRACT

Background: The study of somatotypes has significant implications in understanding physical health, fitness, and disease predisposition. The present study was aimed at analysing the distribution pattern of somatotypes in relation to gender and body mass index (BMI) among health science students in Northern India.
Methods: This study having analytical, cross-sectional design was conducted on 100 students, 63 females and 37 males, aged 18-25 years pursuing a medical or paramedical course at Kalpana Chawla Government Medical College (KCGMC), Karnal, Haryana, India. Somatotype was determined using Heath-Carter anthropometric method. Anthropometric measurements were done using standardised equipments. Data was presented using appropriate descriptive and analytical statistical measures. $P<0.05$ was considered for rejecting null hypothesis.
Results: Endomorph emerged as the predominant (65%) somatotype in our sample, followed by mesomorph. Somatotypes distribution exhibited significant gender and BMI dependence. Endomorphy and ectomorphy were more prevalent among female students as compared to their male counterparts, and mesomorphy among males (40.54% vs. 11.11%, respectively). The mean somatotype scores of female and male participants were 5.10-3.64-2.84 and 4.55-4.34-1.54, respectively. A modest to strong, significant correlation was observed between somatotype components and BMI. A higher proportion of endomorphs was observed in normal weight than overweight participants (75.41% and 59.09%, respectively).
Conclusions: Endomorphy is prevalent in health science student population. Somatotypes distribution is influenced by gender and BMI. Study suggests that BMI should be combined with other measures such as somatotype to more reliably assess relative fatness in individuals.

Keywords: Anthropometry, Body mass index, Endomorphy, Health science students, Somatotype

INTRODUCTION

Somatotyping, the classification of human physique into distinct body types based on anthropometric measurements, has significant implications in understanding physical health, fitness, and disease predisposition. The concept was originally introduced by William Herbert Sheldon in the 1940s and later refined by Heath and Carter, categorizes individuals into three primary types: ectomorph, mesomorph, and endomorph, each representing a unique combination of body build and composition. Ectomorphs are typically characterized by a lean and slender body with low fat and muscle mass, mesomorphs by a muscular and well-built physique, and endomorphs by a higher proportion of body fat and a rounder body shape. Somatotype reflects combined influence of genetic, environmental and life style factors. A widely used modern approach to determine an individual's somatotype is the Heath–Carter anthropometric somatotype method based on measuring specific anthropometric variables such as skinfold

thickness, bone breadths, limb girths, height, and weight.[1–3]

Somatotyping has been widely applied in fields such as sports science, anthropology, and human biology. It has been utilized to analyse and compare athlete's body types across different competitive levels and a wide range of sports.[4–6] In sports performance analysis, different somatotypes are often associated with advantages in particular activities. For example, athletes in endurance sports such as long-distance running tend to exhibit more ectomorphic characteristics, whereas sports requiring strength and power, such as weightlifting or wrestling, often favour mesomorphic physiques.[7,8] Somatotyping has also been used to examine changes in body physique during growth,[9,10] illness,[11] training and physical performance,[7] as well as in relation to nutritional factors.[12]

Health sciences students represent an important demographic for such studies due to their future roles in healthcare delivery and health promotion. Assessing somatotype patterns within this group in Northern India, a region characterized by diverse ethnicities and nutritional profiles, can provide valuable insights into their health status, potential risk factors for lifestyle- related diseases and contribute to the global anthropometric database. This study was aimed to stratify somatotype distribution by gender and body mass index (BMI) among health science students in Northern India to elucidate the relationship between body composition, gender, and BMI in this population.

METHODS

Study design and setting

The present study having an observational, cross-sectional design was conducted in the Department of Physiology at Kalpana Chawla Government Medical College (KCGMC), Karnal, Haryana, India from May to September 2024 after obtaining ethical clearance from Institutional ethical committee (vide letter number KCGMC/IEC/2024/193 dated 01/04/2024).

Participants

A total of 100 participants in the age group of 18-25 years, of either gender enrolled in the present study. All the participants were students of the KCGMC enrolled in various courses i.e. M.B.B.S. and Paramedical courses (BPT, BSc MLT, BSc Optometry, BSc Radiology). Students were briefed about the purpose, risks, and implications of the study and only volunteers were recruited. Those who showed unwillingness or had history of any endocrine or growth abnormalities were excluded. Written informed consent was obtained from the participants, prior to the initiation of the study.

Anthropometry

Body mass index (BMI) was calculated by dividing body weight (kg) by height (m) squared. The BMI categories as per WHO classification were classified as: underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), and obese (>30.0).[13]

Anthropometric somatotype was determined using Heath-Carter method. Ten anthropometric dimensions are needed to calculate the anthropometric somatotype: stretch stature, body mass, four skinfolds (triceps, subscapular, supraspinal, medial calf), two bone breadths (biepicondylar humerus and femur), and two limb girths (arm flexed and tensed, calf). The bicondylar humerus and bicondylar femur breadths were measured using Mitutoyo vernier calliper accurate to 0.1mm. Skinfolds were measured at the following sites: triceps, subscapular, supraspinal, and medial calf skin fold using a Right Gear skinfold calliper accurate to 2mm. Girths were measured at the following sites: flexed and tensed arm and calf with a Rushwak anthropometric tape accurate to 0.1cm.

Following equations were used for calculating somatotype components ratings:

Endomorphy=−0.7182+0.1451(X)−0.00068(X2)+0.0000014(X3)

(where X= sum of triceps, subscapular and supraspinal skin folds) multiplied by (170.18/height in cm). This is called height-corrected endomorphy and is the preferred method for calculating endomorphy.

Mesomorphy = 0.858×humerus breadth+0.601×femur breadth+0.188×corrected arm girth+0.161×corrected calf girth−0.131×height+4.5

Ectomorphy: Three different equations are used to calculate ectomorphy according to the height–weight ratio (HWR). If the HWR is greater than or equal to 40.75, then ectomorphy=0.732 HWR 28.58. If HWR is less than 40.75 but greater than 38.25, then ectomorphy=0.463 HWR−17.63. If HWR is equal to or less than 38.25, then ectomorphy=0.1.

Somatotype of an individual is represented as a three-number rating (X-X-X) example 2-1-1, in which each number represents a somatotype variable. The first digit represents endomorphy (relative fatness), the second digit represents mesomorphy (muscularity) and the last digit reflects the component of ectomorphy (relative linearity). There are 13 identified somatotype categories that have been divided into four larger categories: Central: no component differs by more than one unit from the other two. Endomorph: endomorphy is dominant, mesomorphy and ectomorphy are more than one half unit lower. Mesomorph: mesomorphy is dominant, endomorphy and ectomorphy are more than one half unit lower. Ectomorph:

ectomorphy is dominant, endomorphy and mesomorphy are more than one half unit lower.[3]

Statistical analysis

Data was compiled and analysed using Statistical Package for Social Sciences (SPSS) for Windows version 26.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics was presented using mean and standard deviation for continuous variables and frequency (percentage) for categorical. Gender differences in mean anthropometric parameters were analysed for statistical significance using unpaired t-test. Chi square test of independence was used to assess gender and BMI category differences in somatotypes distribution. Linear relationship between BMI and somatotype components scores was determined using Pearson's correlation analysis. P<0.05 was considered as statistically significant.

Anthropometric measurements and distribution based on BMI categories of male and female respondents are depicted in Table 1. A significant gender difference in height, weight and BMI was observed. Majority of the students (n=61) were in the normal weight category, followed by overweight (n=22) and underweight being the least in number. There were no obese respondents. Compared with male participants, females showed higher prevalence of thinness. On the contrary, frequency of overweight was higher in male students as compared to female students, 51.3% (19/37) vs. 4.7% (3/63), respectively.

Table 1: Comparison of anthropometric parameters between male and female participants.

Variables	Total (n=100)	Males (n=37)	Females (n=63)	P value
Weight (kg)	60.1 (13.08)	74.4 (7.08)	51.7 (7.04)	<0.001
Height (cm)	164.3 (7.92)	172.5 (4.62)	159.3 (4.90)	<0.001
BMI (kg/m^2)	22.07 (3.37)	25.62 (1.08)	19.32 (2.42)	<0.001
BMI category, N (%)				
Underweight	17	-	17 (27)	<0.001
Normal weight	61	18 (48.64)	43 (64.17)	
Overweight	22	19 (51.35)	3 (4.76)	

*Data for continuous variables presented as mean (SD)

Table 2: Frequency distribution of Somatotypes based on gender and BMI category (n=100).

Variable	Gender			BMI category			
Somatotype	**Males (n=37)**	**Females (n=63)**	**P value**	**Underweight (n=17)**	**Normal (n=61)**	**Overweight (n=22)**	**P value**
Endomorph (n=65)	20 (54.05%)	45 (71.43%)		6 (35.29%)	46 (75.41%)	13 (59.09%)	
Mesomorph (n=22)	15 (40.54%)	7 (11.11%)	0.002	0	13 (21.31%)	9 (40.91%)	<0.001
Ectomorph (n=13)	2 (5.41%)	11 (17.46%)		11 (64.71%)	2 (3.28%)	0	

*Statistical significance determined using Chi-square test of Independence.

Somatotypes distribution pattern

Endomorphs were the most common (65%, 65/100) somatotype in our study group followed by mesomorphs (22%, 22/100) (Figure 1). The mean somatotype score of females being 5.10-3.64-2.84 and males was 4.55-4.34-1.54.

Table 2 depicts the somatotype distribution of respondents based on gender and their BMI. Significant ($\chi 2$=12.86, p=0.002) gender differences were observed in somatotypes distribution. Endomorphy and ectomporphy was more prevalent in female students than their male counterparts. While mesomorph dominant somatotype was reported more frequently in male participants, 40.54% (15/37) and 11.11% (7/63), respectively. Males had nearly five times the odds of being mesomorph than endomorph (OR=4.82, 95% Confidence limits=1.70, 13.6). Somatotypes distribution was further analysed according to their BMI category. It was observed that the proportion of endomorphs was higher in normal weight than overweight individuals, 75.41% (46/61) vs. 59.09% (13/22), respectively. On the contrary, mesomorphy was found to be more common in overweight participants. Majority (64.71%, 11/17) of the underweight students had ectomorphic somatotype. Furthermore, correlation analysis revealed a positive and significant relationship of BMI with endomorphy (r=0.32, p=0.001) and mesomorphy (r=0.65, p<0.001). Mesomorphic somatotype showed a higher degree of correlation. In contrast, ectomorphy had a strong, negative correlation with BMI (r=-0.93, p<0.001).

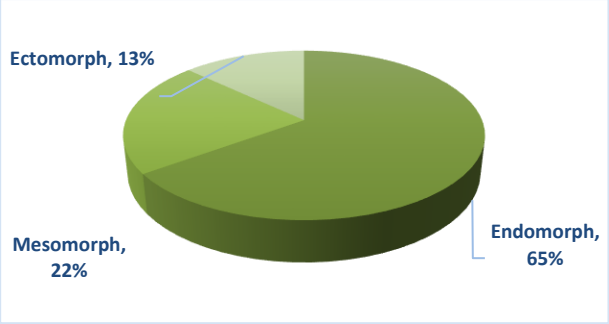


Figure 1: Distribution of study participants (n=100) based on somatotype.

DISCUSSION

Understanding somatotype distribution is essential for assessing health risks, physical performance potential, and nutritional status. This knowledge may inform interventions promoting healthy body image and lifestyle habits among young adults engaged in healthcare education. Keeping this in mind, this study analysed distribution pattern of somatotypes in a cohort of health science students in Northern India and also examined its association with gender and body mass index.

Male students were taller, heavier and had higher BMI than their female counterparts in our sample. In our study, 27% of female students were in underweight category as per BMI. Manan et al in their study on 180 college students in Malaysia reported a 15% prevalence of underweight as compared to Huda et al who reported a higher prevalence of underweight (33%) among female students.[14,15] The high prevalence of underweight among female university students may be due to their desire for thinner body size.[16]

Female students in the present study had higher endomorphy and ectomorphy than male students as indicated by their mean somatotype scores (5.10-3.64-2.84 for females and 4.55-4.34-1.54 for males, respectively). The somatotype components score of female participants in our study is consistent with the score reported by Pastuszak et al in their study among female students from the Warsaw University of Technology. They have reported a somatotype score of 5.1-3.6-2.8 in female students with a significantly greater endomorphic participation.[17] A similar pattern of somatotype score (endomorphy component greater in females than males and mesomorphy in males) was observed in a study among medical undergraduate students of a university in Nigeria.[18] A study conducted in the same region (Northern India) several decades ago on a large sample (n=1000) of male college students reported an ectomorphic dominant pattern in somatotype score (2.85-2.96-4.56).[19] This difference may be attributed to shifts in dietary patterns and levels of physical activity among college students over the years.

A significant gender dependence in somatotypes distribution was observed in our study. Endomorph was the prevailing somatotype in female respondents while males dominated among mesomorphs. Khasawneh et al in their study among physical education college students reported balanced endomorph somatotype as the prevailing one among females whereas mesomorphic endomorph somatotype was more common among males.[20] Earlier cited study among medical undergraduates of a university in Nigeria observed a somatotype distribution pattern in alignment with our findings. Male medical students showed a fairly consistent pattern of dominant mesomorphy with 24.6% endomorphic mesomorphs, 23.1% balanced mesomorphs and 13.9% ectomorphic mesomorphs. Females clustered around endomorphy.[18] The observed morphological differences between the two sexes may result from a combination of genetic influences, dietary habits, levels of physical activity, hormonal, and other socio-cultural or environmental factors.

Analysis of somatotype distribution in relation to BMI categories revealed a higher proportion of mesomorphs in overweight participants than in normal weight (41.9% vs. 21.3%, respectively). Also, only a weak correlation was observed between endomorphy component and BMI. Study among Nigerian medical students concurred with the above findings. The significant difference between male and female endomorphy, a measure of relative fatness, was not reflected in their BMI.[18] These findings could be explained by the fact that muscle mass is dense than fat mass. Based on such observations, Dulloo et al reasoned that use of BMI may misclassify individual with mesomorph dominant somatotype as overweight and obese.[21]

CONCLUSION

Endomorph emerged as the most prevalent somatotype, followed by mesomorph among health sciences students. Significant gender and BMI dependence was observed in somatotypes distribution. Endomorphy and ectomorphy were more prevalent in females than males and mesomorphy among male students. Endomorphy and mesomorphy components increased with BMI, while ectomorphy showed an inverse relationship with BMI. Among respondents with normal BMI, it was found that they have high endomorphy score indicating that BMI alone cannot distinguish the hidden fat in the body. Thus, we suggest that in spite of using BMI as tool to measure fatness, the somatotype method should be also used as it is a more sensitive method to measure body fatness in individuals.

ACKNOWLEDGEMENTS

Authors would like to convey their heartfelt thanks to all the study participants for their wholehearted co-operation and participation in this research project.

Funding: No funding sources
Conflict of interest: None declared
Ethics approval: Research project was approved by the institutional ethics board of KCGMC, Karnal (KCGMC/IEC/2024/193)

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Cite this article as: Sethi J, Singh M, Khurana R, Kaushik NK. Somatotype stratification by gender and body mass index among health science students in Northern India. Int J Res Med Sci 2026;14:5807-11.