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Body Somatotype, Anthropometric Characteristics and Physical Activity of College-Age Adults in Selected Institutions of Higher Learning in Kelantan, Malaysia

Wan Abdul Manan WM, Kum CS & Lee YY

Program in Nutrition, School of Health Sciences, Universiti Sains Malaysia Health Campus Kelantan Malaysia.

ABSTRACT

Introduction: The objective of this cross-sectional study was to determine the body somatotypes, anthropometric characteristics and physical activity levels of young adults. **Methods:** Using a systematic sampling approach, a total of 180 students were recruited from three institutions of higher learning in the state of Kelantan. Body weight, height and other anthropometric dimensions including skinfold, bone breadth and limb girth were measured to determine their body mass index (BMI) and body somatotypes. Physical activity level was determined using the Short Form – International Physical Activity Questionnaire (IPAQ). **Results:** Almost half (49.4%) of the respondents were with a mean age of 21.5 (1.5), and mean BMI of 22.1 (4.5) kg/m^2. The proportion of overweight and obese respondents based on the World Health Organisation (WHO) classification was 17.2% and 6.7%, respectively. In terms of body somatotype, 57.2% and 18.3% of them were classified as endomorphic and mesomorphic somatotype groups respectively, while another 24.4% were ectomorphic. The IPAQ scoring protocol indicated that 35.0% of them achieved high physical activity levels, while 19.3% reported low physical activity levels. There were significantly more endomorphic females, whereas the males significantly dominated the mesomorphic somatotype group. **Conclusion:** Respondents with mesomorphic body somatotype (relative muscularity) were categorised as obese under the BMI classification although their body weight could be due to higher skeletal/muscle mass. The somatotyping method can be used as an additional tool to the conventional BMI indicators for assessing adiposity.

Key words: Anthropometric characteristics, body somatotype, college-age adults, physical activity, young adults

INTRODUCTION

Malaysia is one of the countries which has seen increased prevalence of non-communicable diseases largely due to a high prevalence of physical inactivity (Wan Rabiah, Petterson & Pegg, 2011). The National Health and Morbidity Survey (NHMS) conducted in 2011 reported that the prevalence of overweight and obesity among Malaysian adults was 33.3% (5.4 million people) and 27.2% (4.4 million people), respectively (Institute of Public Health (IPH), 2011). A substantial increase

Correspondence: Wan Abdul Manan Wan Muda; Email: *wanmanan@usm.my*

is noted compared to the previous report, the Third National Health and Morbidity Survey (NHMS III) conducted in 2006, where the prevalence of overweight was 28.6% and obesity 14.6% (IPH, 2008). Furthermore, there was also an increase in the prevalence of diabetes mellitus (from 14.9% in 2006 to 15.2% in 2011) and hypertension (from 14.6% in 2006 to 35.1% in 2011) among Malaysian adults in both surveys. An unhealthy lifestyle such as frequent and uncontrolled intake of foods high in sugar and fat, and processed and fast foods contributed to the increase in the prevalence of overweight, obesity, diabetes and hypertension among Malaysians (National Coordinating Committee on Food and Nutrition (NCCFN), 2010). The increases in the prevalence of the above weight and medical conditions were also contributed by the lack of physical activity (NCCFN, 2010).

Body Mass Index (BMI), commonly used as a measure of fatness, has significant practical advantages and is familiar to most health practitioners. This perception is reinforced by the use of this method as an indicator of health risk and life expectancy by insurance companies (Eston *et al.*, 2009). However, BMI does not measure body fat, frame size and lean tissue (Ghosh *et al.*, 2004) and application of the BMI to represent adiposity is limited and has attracted strong criticism (Eston *et al.*,2009). The authors argue that individuals of the same height will vary with respect to frame size, tissue densities and proportion of various body tissues. An individual may be heavy for his stature because of excess adipose tissue and another may be heavy because of a large skeleton and muscle mass, suggesting the relevance of body somatotyping.

Somatotype is a quantification used to describe the human physique based on a number of traits that relate to the present shape and composition of the human body (Carter & Heath, 1990). It reflects an overall outlook of the body and expresses the meaning of morphological features of the human body as a whole (Singh *et al.*, 2007). The Heath-Carter somatotype method is the most commonly used method to determine body somatotype. The three components of somatotyping are endomorphy, mesomorphy and ectomorphy.

Endomorphy describes the relative degree of adiposity and soft roundness of the body, regardless of where or how it is distributed. Endomorphs have large digestive viscera and accumulations of fat tissue, with large trunk and thighs and distal tapering of the limbs (Duquet & Carter, 2009). Meanwhile, mesomorphs can be seen with robustness of the body in terms of muscle or bone, the relative volume of the thoracic trunk and the possibly hidden muscle bulk (Duquet & Carter, 2009). Mesomorphy represents relative muscularity or musculo-skeletal development of the body, and is classified between ectomorphy and endomorphy. Ectomorphy represents relative linearity and slenderness of the body, and ectomorphs have a type of body build with large surface area with apparent linearity of the body or fragility of the limbs, in the absence of any bulk such as muscle, fat or other tissue (Duquet & Carter, 2009). Changes in somatotype occur during childhood to maturity, but can be altered through training and/or nutrition (Ronco *et al.*, 2008). Body somatotype has great variability within individuals and may be determined partly by energy intake and physical activity, as well as by sex, age, genetic variability and the socio-cultural environment (Duquet & Carter, 2009).

Physical activity can be defined as a form of movement that involves energy expenditure (Basrur, 2003), or a behaviour depending on human preference of the type, frequency, duration or intensity of activities (Luke *et al.*, 2004). The health benefits of physical activity are widespread over the human life cycle. Sedentary lifestyle is becoming more prevalent

worldwide. It is one of the factors that leads to hypertension, hyperlipidemia, hyperglycemia and increases in overweight and obesity in children and adults, both in developed and many developing countries. It is also the fourth leading risk factor of mortality worldwide as it increases the risks of heart disease, stroke, diabetes and cancer, and contributes to over three million preventable deaths annually (World Health Organisation (WHO), 2009).

A recent report indicated that about 60% of the world's adult population failed to meet the WHO recommendations of at least 30 minutes of moderate or vigorous physical activity daily for adults (WHO, 2012). The NHMS III conducted in 2006 utilised the Global Physical Activity Questionnaire (GPAQ) to measure physical activity and the data showed that 35.3% and 50.5% of Malaysian men and women were physically inactive, respectively (IPH, 2008; Chan *et al.*, 2014). Meanwhile, the NHMS (2011) indicated that 64.8% of Malaysian adults are categorised as physically active according to the International Physical Activity Questionnaire (IPAQ) definition (IPH, 2011). Another national survey termed the Malaysian Adults Nutrition Survey (MANS) revealed that only 14% of the Malaysian population had adequate exercise (Poh *et al.*, 2010).

There are limited studies on body somatotyping and physical activity levels among younger adults in Malaysia. Existing studies in Malaysia focus on somatotype profiles and differences among elite netball and basketball players below 18 years old based on player position and team performance (Soh *et al.*, 2009). A recent study was on anthropometric correlates of motor performance among Malaysian university student athletes aged 18 to 28 years old who represented their universities in the ASEAN University Games 2008 (Amri *et al.*, 2012). Therefore, the objectives of this study are to profile the body somatotypes of young college-age adults studying in selected institutions of higher learning in the state of Kelantan, Malaysia and to determine their nutritional status and physical activity levels as a whole and in each somatotype group.

METHODS

Study location and study design

A total of 180 college-age adults pursuing their diplomas and bachelors were enrolled in this cross-sectional study. Their ages were between 19 to 25 years old from three different institutions of higher learning (2 public universities and one nursing college) located in Kota Bharu, the capital city of Kelantan. Lists of students were obtained from the respective institutions and students who were selected systematically from the lists were invited to participate in the study. Students who agreed to join were given detailed explanation regarding the study and signed the written informed consent forms before the study commenced.

The ethical approval for this study was obtained from Universiti Sains Malaysia's Research Ethics Committee (Human). Permission to carry out data collection was also obtained from the students' affairs office of each respective institution of higher learning in Kota Bharu.

Sample size calculation

The single proportion formula, $n=[Z^2P\ (1 - P)]/\ d^2$, was used to calculate the sample size, where Z represents confidence level at $p<0.05$, P indicates the prevalence of overweight and obesity among undergraduate students in a Malaysian local university in Selangor (Hazizi *et al.*, 2012) and d is the desired degree of precision. A sample size of at least 183 respondents was needed for this study. After taking into account 10% of non-response rate, 201 students were systematically selected from the lists and only 180 of them participated successfully (response rate was 89%).

Anthropometric measurements

Body weight was measured using a SECA digital weighing scale (Model 880, Hamburg, Germany) to the nearest 0.1 kg. The SECA Bodymeter (Model 208, Hamburg, Germany) was used to measure height to the nearest 0.1 cm. The equipments were calibrated prior to each measurement session. All measurements were taken according to the standard procedure, twice and the mean value was used for data analysis. They were dressed minimally and without shoes. The BMI of each respondent was calculated using the standard formula BMI = weight (kg) / height^2 (m) and classified according to the recommendations by WHO. The WHO BMI cut-off point is a recognised international classification for all adult men and women (WHO Expert Consultation, 2004).

Anthropometric somatotype

Anthropometric somatotypes were calculated using the Heath-Carter Somatotype Rating Form according to the Heath-Carter anthropometric method (1990) to classify the respondents into endomorphy, mesomorphy and ectomorphy somatotypes. Measurements obtained were transferred into a blank Heath-Carter Somatotype Rating Form according to the steps shown in the Heath-Carter Anthropometric Somatotype Instruction Manual (Carter, 2002). Besides body weight and stature, an additional eight anthropometric measurements were obtained, namely the upper arm and calf circumferences, triceps, subscapular, calf and supraspinale skinfolds, as well as bicondylar breadths of the humerus and femur. Skinfolds and bone breaths were measured using a Harpenden Skinfold Caliper (Baty International, England) and a Rosscraft Campbell 10 small bone caliper (Rosscraft Innovations Incorporated, Canada), respectively, while limb girths were measured using an anthropometic measuring tape (Rosscraft Innovations Incorporated, Canada). The equipment were calibrated before each measurement session. All skinfolds, bone breaths and limb girths measurements were taken twice on the right side of the body by a single measurer (the corresponding author), who is a Level-3 Anthropometrist certified by the International Society for the Advancement of Kinanthropometry (ISAK). Limb girth was read to the nearest 0.1 cm, while bone breath and skinfold were read to the nearest 0.5 mm and 0.1 mm on the calipers, respectively.

Physical activity

Physical activity levels of the respondents were assessed using the International Physical Activity Questionnaire (IPAQ – Short form) in the Malay Language. The validated version of the translated Malay Language IPAQ – Short Form is publicly accessible on IPAQ's website (www.ipaq.ki.se). The questionnaire consists of four components - time spent on vigorous intensity activity, moderate intensity activity, walking, and sitting/ lying down (exclusive of sleeping) per day. The respondents' physical activity was classified into three different physical activity levels (low, moderate and high) based on the scores calculated using the recommendations of the IPAQ Scoring Protocol. The IPAQ – Short form had demonstrated reliability and validity against accelerometers, and was thus was suitable for surveys and studies at the population level (Bauman *et al.*, 2009).

Statistical analysis

Respondents were divided into groups according to their sex, anthropometric characteristics and physical activity levels to assess the difference of these classifications between different body somatotypes. Descriptive analyses included frequencies, means and standard deviation values. Pearson's Chi-squared test was used to determine whether the distribution of

Table 1. Age, sex, ethnicity, institution and classification of body somatotype, anthropometric characteristics (BMI) and physical activity level

Variables	*n*	*Percentage (%)*	*Mean (SD)*
Age (years)			21.5 (1.5)
19 years	15	8.3	Median: 21.0
20 years	29	16.1	
21 years	63	35.0	
22 years	26	14.4	
23 years	26	14.4	
24 years	13	7.2	
25 years	8	4.4	
Sex			
Female	91	50.6	
Male	89	49.4	
Ethnicity			
Malay	107	59.4	
Others (Chinese and Indian)	73	40.6	
Institution			
Public University 1	49	27.2	
Public University 2	83	46.1	
Nursing College	48	26.7	
Body Somatotype			
Endomorphy	103	57.2	
Mesomorphy	33	18.3	
Ectomorphy	44	24.4	
Body Mass Index (BMI) [kg/m2]			22.1 (4.5)
Underweight	35	19.4	Median: 21.3
Normal	102	56.7	
Overweight	31	17.2	
Obese Class I	9	5.0	
Obese Class II	3	1.7	
Physical Activity Level			
Low	25	19.3	
Moderate	92	51.1	
High	64	35.0	

categorical variables such as classification of anthropometric characteristics (BMI), body somatotype and physical activity levels were different between male and female respondents. One-way ANOVA was used to assess whether a significant difference existed in the mean BMI and Total Metabolic Equivalent (MET) values as measured by the IPAQ between the three groups of body somatotypes. Analysis was performed using IBM SPSS Statistics Version 19.0 (SPSS Inc., Chicago, IL, USA). The level of significance was set at $p<0.05$.

RESULTS

The respondents' age, sex, institution, body somatotype, anthropometric characteristics and physical activity levels are presented in Table 1. Mean age of the respondents was 21.5 (1.5) years old, with 50.6% of the respondents being female. A majority of them (56.7%) had normal BMI, with a mean of 22.1 (4.5) kg/m^2. About 26.7% of the respondents were from a nursing college, while the remaining were from local public universities.

Table 2. Anthropometric measurements, total metabolic equivalent (MET) values, BMI and physical activity level of male and female respondents

Anthropometric measurements and MET	*Male mean (SD) [Median]*	*Female mean (SD) [Median]*	*Total mean (SD)*	*p*
Weight (kg)	66.1 (13.8) [63.0]	52.7 (12.0) [50.0]	59.3 (14.5)	$p<0.001$
Height (cm)	170.0 (6.0) [171.0]	156.6 (4.8) [157.0]	163.4 (8.7)	$p<0.001$
BMI (kg/m2)	22.7 (4.1) [21.6]	21.5 (4.7) [21.0]	22.1 (4.5)	$p>0.05$
Total metabolic equivalent (MET)	3723.7 (3296.4) [2820.0]	2453.3 (3146.2) [1626.0]	3081.5 (3274.8)	$p<0.01$
Classification	n (%)	n (%)	n (%)	
Body mass index				
Underweight	8 (4.4)	27 (15.0)	35 (19.4)	
Normal	58 (32.2)	44 (24.4)	102 (56.7)	
Overweight	17 (9.4)	14 (7.8)	31 (17.2)	
Obese Class I	5 (2.8)	4 (2.2)	9 (5.0)	
Obese Class II	1 (0.6)	2 (1.1)	3 (1.7)	
Physical activity level				
Low	6 (3.3)	19 (10.6)	25 (13.9)	
Moderate	40 (22.2)	52 (28.9)	92 (51.1)	
High	43 (23.9)	20 (11.1)	63 (35.0)	

Anthropometric measurements and total metabolic equivalent (MET) values achieved by both male and female respondents are shown in Table 2. The mean weight and height of male respondents were both significantly higher compared to the female respondents ($p<0.001$). The males also achieved significantly higher mean total metabolic equivalent in physical activity compared to the females ($p<0.01$). However, there was no significant difference in the mean BMI values between the two sexes.

The frequency of body somatotypes of the respondents, grouped according to their sex, BMI and physical activity level, is shown in Table 3. There were significantly more females classified under the endomorphy somatotype group, whereas the males significantly dominated the mesomorphy somatotype group. Several respondents with mesomorph somatotype were categorised as overweight and obese under the BMI classification. Meanwhile, there were a larger number of endomorphic respondents (7.8%) categorised as having low physical activity level compared to mesomorphic (1.7%) and ectomorphic (4.4%) respondents, respectively.

Table 4 shows the mean values of body weight, height, BMI and MET values in the three different somatotype groups. Significant differences are noted between the three groups in terms of body weight and BMI.

DISCUSSION

Somatotyping is an estimation of physique with visual impression using anthropometry and/or photographs. It

Table 3. Frequency in body somatotype groups by sex, BMI and physical activity level

Variables	*Body Somatotypes*		
	Endomorphy n (%)	*Mesomorphy n (%)*	*Ectomorphy n (%)*
Sex			
Female	62 (34.5)***	7 (3.9)**	22 (12.2)
Male	41 (22.8)***	26 (14.4)**	22 (12.2)
Body Mass Index			
Underweight	6 (3.4)	1 (0.6)	28 (15.6)
Normal	62 (34.4)	24 (13.3)	16 (8.8)
Overweight	27 (15.0)	4 (2.2)	0 (0.00)
Obese Class I	6 (3.4)	3 (1.7)	0 (0.00)
Obese Class II	2 (1.1)	1 (0.6)	0 (0.00)
Physical activity level			
Low	14 (7.8)	3 (1.7)	8 (4.4)
Moderate	52 (28.9)	13 (7.2)	27 (15.0)
High	37 (20.6)	17 (9.4)	9 (5.0)

Pearson Chi-Square ***$p<0.001$, **$p<0.01$

Table 4. Differences in mean values of weight, height, BMI and total metabolic equivalents (MET) between body somatotypes groups

Anthropometric measurements and MET values	*Endomorphy mean (SD) [Median]*	*Mesomorphy mean (SD) [Median]*	*Ectomorphy mean (SD) [Median]*	*p*
Weight (kg)***	62.9 (14.5) [61.0]	63.2 (13.4) [60.0]	47.6 (7.9) [47.0]	$p<0.001$
Height (cm)	162.8 (9.7) [161.0]	164.4 (7.3) [165.0]	164.1 (7.4) [163.0]	$p>0.05$
BMI (kg/m2)**	23.6 (4.0) [22.6]	23.3 (4.5) [21.5]	17.6 (1.6) [17.8]	$p<0.005$
Total metabolic equivalent (MET) values	3164.6 (3196.8) [2266.5]	3732.5 (3138.9) [2866.5]	2389.6 (3500.2) [1415.3]	$p>0.05$

One-Way ANOVA **$p<0.005$, *** $p<0.001$

is also a measurement technique that has been used mostly for fitness and athletic assessment, but used infrequently within the medical field although previous studies had mainly related body somatotypes with obesity and cardiovascular risk (Ronco *et al.*, 2008). High endomorphy somatotype (relative adiposity) has been positively and significantly associated with breast cancer among women in Uruguay (Ronco *et al.*, 2008). Meanwhile, predominance of mesomorphic somatotype (relative muscularity) can be caused by increased physical activity, where there is higher volume of fat-free body mass compared to the volume of fat mass (Perecinska, Vadasova & Souskova, 2013). This was observed in a group of young female

gymnasts in Slovak whose somatotype assessment indicated that 57% of them were mainly mesomorphic (Perecinska, Vadasova & Souskova, 2013).

In this study, respondents with mesomorphy body shape were found to be physically more active (in terms of MET values) compared to other respondents with other body somatotypes. MET values were also lower among ectomorphic (relative slenderness) compared to endomorphic respondents, although the difference was not significant. It was also observed that the mean BMI values of both endomorphy and mesomorphy (relative muscularity) somatotype groups were similar at 23.6 (4.0) kg/m^2 and 23.3 (4.5) kg/m^2, respectively (Table 4).

Young mesomorphic adults were categorised as overweight and obese under the BMI classification although their weight may be contributed by muscle mass (Table 3). This reinforces the statement by Ghosh and colleague that BMI had been commonly used to measure overall adiposity, but it does not measure body fat, frame size and lean tissue (Ghosh *et al.*, 2004).

In a survey conducted in Spain, female university students aged 18 to 33 year old displayed higher rates of endomorphy (Munoz-Cachon *et al.*, 2007). Similar to our study, mesomorphy tended to be higher among males and the distribution of ectomorphy appeared to be equal among both sexes (Munoz-Cachon *et al.*, 2007). Meanwhile, in a random sample of 140 students enrolled in a military training module in two public institutions of higher learning in Kuala Lumpur and Selangor, it was noted that 6.4% of the students were underweight, and another 10.7 and 3.6% were overweight and obese, respectively (Zulaikha *et al.*, 2011). They were within the age range of 20 to 34 years. In terms of physical activity, the majority of the students (77.9%) were categorised as active, while 20.7% and 1.4% were moderately active and sedentary, respectively, according to the classification of WHO for physical activity level (Zulaikha *et al.*, 2011). Zulaikha and colleagues (2011) stated that most of the students should generally have a normal BMI if they were all undergoing military training, but explained that overweight trainees encountered weight gain during examination periods when there was less training and physical activity sessions.

The results of the present study also showed that 17.2% and 6.7% of the college-age adults in three selected institutions of higher learning in Kota Bharu were overweight and obese, respectively, whereas 19.4% of them were underweight. Meanwhile, in another local study among undergraduates in a local university in Selangor, the prevalence of overweight and obesity was 10.4% and 3.4%, respectively (Hazizi *et al.*, 2012). Prevalence of overweight and obesity was higher in the present study, but the trend of underweight and obesity among the respondents in the present study and that of Hazizi and colleagues' study was similar. This is because there was a slightly higher percentage of obesity among the male respondents, whereas the prevalence of underweight among female respondents was much higher (15.0% in females compared to 4.4% in males in this study). On the other hand, the prevalence of overweight and obesity was slightly higher among females (7.1%) compared to males (6.1%) in a sample of university students in four universities in the Klang Valley, Malaysia (Gan *et al.*, 2011). Nevertheless, the prevalence of underweight among females in Gan's study was also higher at 13.2% compared to 5.7% in males. The high prevalence of underweight among female university students can be due to their desire to have a slimmer body and smaller size, as supported by Sakimaki *et al.* (2005).

A study among 200 conveniently sampled university students in four institutions of higher learning in Selangor (two public and two privately funded institutions) aged 18 to 26 years old reported

that 20.9% of them were underweight, while another 10.0% and 8.2% were overweight and obese (Abdull Hakim, Muniandy & Danish, 2012). Ganasegaran *et al.* (2012) in another survey conducted among a group of medical students studying in a private institution of higher learning in Malaysia reported that 22.7% of the students were underweight, while 24.3% of them were categorised as pre-obese and obese class I. However, no comparison can be made between the study of Ganasegaran *et al.* (2012) and our present study because the WHO BMI cut-offs for the Asian population was used to classify nutritional status of the respondents for the former study, while the latter used the WHO International BMI Classification. In terms of physical activity, 22.0% of the students in the study of Ganasegaran *et al.* (2012) self-reported that they did not perform exercise at all. A survey on young Malaysian adults of the general population indicated that more than half of the participants (56%) who answered the online poll survey had sufficient physical activity, while another 25% of them had achieved very minimal physical activity (Sreeramareddy *et al.*, 2012). In the study of Sreemareddy *et al.*(2012), sufficient physical activity was defined as performing at least 840 MET minutes/week from the combination of walking, moderate and vigorous intensity activities, and was assessed using the Short version IPAQ. Exact comparisons of physical activity levels among young adults in the country are limited due to the existence and use of different types of questionnaires and survey instruments to evaluate self-reported physical activity.

The prevalence of overweight and obesity among college-age adults in this study was relatively higher compared to college-age adults in institutions of higher learning in Kuala Lumpur and Selangor (Zulaikha *et al.*, 2011; Hazizi *et al.*, 2012; Abdull Hakim, Muniandy & Danish, 2012; Ganasegaran *et al.*, 2012). All the respondents in this study lived in a hostel under the administration of the respective institution in the proximity of the university grounds. Students starting college life and living away from home are prone to unhealthy dietary patterns as they tend to develop more unfavourable eating habits (Papadaki *et al.*, 2007) and can be more susceptible to gain weight (Hoffman *et al.*, 2006). Young adulthood is a period when youngsters transitioning into university life are more likely to start building up poor eating habits, indulge in substance abuse and have low physical activity level (Nelson *et al.*, 2008). Fast food outlets and food outlets that operate until late at night were seen operating near all the three institutions of higher learning based on observations by the investigators, but further investigations should be initiated to probe the young adults' eating habits and fast food consumption.

CONCLUSION

In the current study, respondents with mesomorphic somatotype (relative musculariy) were categorised as obese under the BMI classification even though their body weight might be contributed by skeletal or muscle mass, which makes them heavier. Thus, assessment of adiposity levels using the somatotyping method may provide a more accurate way to predict obesity alongside the conventional BMI method. Moreover, the prevalence of low physical activity level and overweight and obesity among these young adults should be noted and they should be urged to be more physically active.

Sports complexes, facilities and tracks for walking and jogging in university campuses should be well maintained to encourage overall physical activity among university students staying on-campus and off-campus. The limitations of this study are its cross-sectional design and the small sample size of respondents involved, making it impossible to impose causality on the results. For future studies,

it is suggested that the dietary intake and dietary patterns of these young adults be also investigated to establish the relationship between body somatotypes and dietary intake.

Conflict of interest

There is no conflict of interest involved.

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