RESEARCH ARTICLE

ISAK INTERNATIONAL JOURNAL OF KINANTHROPOMETRY

DOI: 10.34256/ijk2119

Somatotype and Cardiovascular Diseases Risk Factors Among Government Employees In Kuala Terengganu, Malaysia

Khairil Shazmin Kamarudin [1,*], Lee Yi Yi [2], Wan Abdul Manan Wan Muda [3]

[1] Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, 21030, Kuala Terengganu, Malaysia.
[2] Division of Nutrition & Dietetics, School of Health Sciences International Medical University No. 126, Jln Jalil Perkasa 19, Bukit Jalil, 57000 Kuala Lumpur.
[3] Graduate School of Public Health, Alma Ata University, Jl. Brawijaya 99, Yogyakarta 55183 Indonesia.
* Corresponding authors email: ksk@umt.edu.my
DOI: https://doi.org/10.34256/ijk2119
Received: 16 -11-2021, Revised: 19-12-2021; Accepted: 22-12-2021, Published: 31-12-2021

Abstract

Aim: This cross-sectional study was conducted to determine the body somatotype and risk factors for cardiovascular diseases among government employees from Kuala Terengganu, Malaysia. **Methods:** In this research, 308 government employees were recruited as respondents. Body somatotype was determined using the Heath and Carter (1990) method. The risk factors for cardiovascular diseases were determined by measuring fasting blood glucose, total cholesterol (TC), LDL-cholesterol level, HDL cholesterol level and triglycerides level. **Results:** Majority of the respondents were categorized as endomorphy (84.7%), followed by mesomorphy (11.7%) and ectomorphy (3.6%). Means of fasting blood cholesterol level, triglycerides, HDL and LDL cholesterol among respondents were 5.57 mmol/L, 1.55 mmol/L, 1.25 mmol/L and 3.63 mmol/L, respectively. The fasting blood glucose of respondents was in the normal range (5.02 mmol/L), while cholesterol, triglycerides and LDL cholesterol were on borderline high. Mean HDL level of respondents were below desirable level. **Conclusion:** We found that there were significant correlation between ectomorphy components with blood cholesterol, LDL, HDL and blood glucose level; mesomorphy with LDL cholesterol level; and endomorphy with HDL and blood glucose level among respondents ($p<0.05$). As a conclusion, this study has provided useful insights towards the relationship between somatotype components and risk factors of cardiovascular diseases.

Keywords: Somatotype, Endomorphy, Mesomorphy, Ectomorphy, Cardiovascular diseases.

Resumen

Objetivo: este estudio transversal se realizó para determinar el somatotipo corporal y los factores de riesgo de enfermedades cardiovasculares entre empleados gubernamentales de Kuala Terengganu, Malasia. **Métodos:** En esta investigación, se reclutó como encuestados a 308 empleados del gobierno. El somatotipo corporal se determinó mediante el método de Heath y Carter (1990). Los factores de riesgo de enfermedades cardiovasculares se determinaron midiendo la glucosa en sangre en ayunas, el colesterol total (CT), el nivel de colesterol LDL, el nivel de colesterol HDL y el nivel de triglicéridos. **Resultados:** La mayoría de los encuestados fueron categorizados como endomorfia (84,7%), seguida de mesomorfia (11,7%) y ectomorfia (3,6%). Las medias del nivel de colesterol en sangre en ayunas, triglicéridos, colesterol HDL y LDL entre los encuestados fueron 5,57 mmol / L, 1,55 mmol / L, 1,25 mmol / L y 3,63 mmol / L, respectivamente. La glucosa en sangre en ayunas de los encuestados estaba en el rango normal (5,02 mmol / L), mientras que el colesterol, los triglicéridos y el colesterol LDL estaban en el límite alto. El nivel medio de HDL de los encuestados estaba por debajo del nivel deseable. **Conclusión:** Encontramos que existe una correlación significativa entre los componentes de la ectomorfia con el colesterol en sangre, LDL, HDL y nivel de glucosa en sangre; mesomorfia con nivel de colesterol LDL; y endomorfia con HDL y nivel de glucosa en sangre entre los encuestados (p <0,05). Como conclusión, este estudio ha proporcionado información útil sobre la relación entre los componentes del somatotipo y los factores de riesgo de las enfermedades cardiovasculares.

Palabras Clave: Somatotipo, endomorfia, Mesomorfia, Ectomorfia, Enfermedades Cardiovasculares.

Introducción

Somatotype was developed in the 1940s by William Herbert Sheldon, an American psychologist, to relate human body types with temperament types (Rafter 2007, Rosenbaum 1995, Sheldon, 1940). Somatotyping is a unique method for the classification of human physique and is also used to assess body shape and composition (Carter 2002). The somatotype is a type of physique concerning bodily structure, proportions, appearance, and development of a person. It combines an evaluation of relative adiposity, musculoskeletal robustness and linearity into a three number rating. The three number rating represents endomorphy, mesomorphy and ectomorphy component of somatotype respectively (Gakhar and Malik 2002). The Heath-Carter somatotype method is a modification of the original method developed by Sheldon (1940). It is distinguished from Sheldon method by modification which are; the somatotype rating is a phenotypic rating based on the anthropometric measurements. Phenotypic rating is a description of the actual physic, which includes an observable characteristic of an individual, for example, height and weight (Brayton and Treuting 2012).

Somatotype in Heath and Carter (1963) method were expressed as a three numeral rating with one numeral for each of three components of physique, always recorded sequentially. For example the three numerals written as 2-5-3, in which 2 represents the endomorphy, 5 represents the mesomorphy and 3 represents the ectomorphy component. Endomorphy is a score on a continuum of relative fatness of a physique. It is estimated from the sum of three skinfolds adjusted for height. Mesomorphy is a score on a continuum of musculoskeletal robustness, predominance of muscle, bone and connective tissues. It is estimated from two extremity skeletal breadths (femur and humerus), two limb circumferences (upper arm and calf circumferences) corrected for skinfold thickness, and height. Ectomorphy is a score on a continuum of relative linearity or 'stretched-outness' of a physique. It is estimated from the reciprocal ponderal index which are height divided by the cube root of weight (Heath and Carter 1967). Based on Heath and Carter (1967), the lowest score of somatotypes components is 0.1, while the upper end is open. However, normally in the practice most score is between 1 to $8^{1/2}$ (Norton and Olds 1996). In general, component score of 1 to $2^{1/2}$ is regarded as low, rating between 3 to $4^{1/2}$ was regarded as moderate, rating between $5^{1/2}$ to 7 was regarded as high and rating between $7^{1/2}$ to $8^{1/2}$ was extremely high (Norton and Olds 1996).

The word somatotype always implies the three numeral score and recorded together, for example a somatotype for a person can be written as 4-7-1. 4 refer to endomorphy components, 7 refers to mesomorphy components and 1 refers to ectomorphy component. According to these score, somatotypes can be classified into 13 categories, namely: central, balanced endomorph, mesomorphic-endomorph, mesomorph-endomorph, endomorphic-mesomorph, balanced mesomorph, etomorphic-mesomorph, mesomorph-ectomorph, mesomorphic-ectomorph, balanced ectomorph, endomorphic-ectomorph, endomorph-ectomorph and ectomorphic-endomorph. However, these 13 categories can be simplified into 4 larger dominant categories which are central, endomorph, mesomorph and ectomorph. The definition for central category is: there is no component differs by more than one unit from the other two. Endomorph is defined when endomorphy component is dominant, while mesomorph and ectomorphy are more than one-half unit lower. For mesomorph, it is defined when mesomorphy is the dominant component while endomorphy and ectomorphy are more than one-half unit lower. Ectomorph is defined when ectomorph component is dominant while endomorphy and mesomorphy are more than one-half unit lower (Carter 2002).

Body type of an individual that is characterized as endomorphic typically has short limbs (arms and legs) and they have large amount of mass on the body frame. According to Beashel and Taylor (1997), endomorphic individuals are facing difficulties in sports or activities that require high levels of nimbleness and to perform weight-bearing exercises such as running, hiking and jogging. However, the ideal sports for endomorphic individuals are those that require pure strength like power lifting. A mesomorphic individual is expected to excel in activities related strongly to strength, nimbleness, and speed. Beashel and Taylor (1997) identified mesomorph individuals to have moderate body structure and height. In combination with their tendency to increase muscle mass and strength easily, it enables them to be strong contenders for being top athletes in almost any sports. Beashel and Taylor (1997) stated that a predominantly ectomorphic individual is long, slender and thin. Therefore, they are possibly not suitable involved in power and strength sports as they might be susceptible to injuries. Although they can easily get lean and hard, the lack of musculature often limits ectomorphic individuals tend to reduce their chances in sports requiring mass.

The relationship between somatotype and diseases was first investigated by Sheldon et al (1940) by relating the somatotypes with abnormality of behavior and function. His study demonstrated that patients with paranoid schizophrenia have mesomorphic ectomorphic type of physique, while hebephrenic paranoids patients have equal endomorphy and ectomorphy but lack of mesomorphy. (Singh 2007). Started from this, researchers start to relate somatotype with diseases such as Diabetes Mellitus, Osteoarthritis and Cardiovascular Diseases.

Cardiovascular diseases (CVD) are a group of disorder of the heart and heart vessels, which includes coronary heart diseases, cerebrovascular diseases, peripheral arterial diseases, rheumatic heart diseases, congenital heart diseases and deep vein thrombosis and pulmonary embolism (WHO 2021). Excess weight and obesity is the main factor for the cardiovascular disease problem. This condition may lead to insulin resistance, hypertension and dyslipidaemia and finally increased risk for developing CVD (Eckel et al. 2006; Thomas et al, 2005, Jonsson et al. 2002, Schulte et al. 1999). A study by Thomas et al. (2005) stated that risk of cardiovascular death increased significantly when overweight is associated with hypertension and hypercholesterolemia. Unhealthy diets, physical inactivity, tobacco usage and harmful usage of alcohol are among behavioural factors of cardiovascular diseases. The effects of these behavioural factors can lead to the metabolic risk factors which are raised blood pressure, raised triglycerides level, low HDL cholesterol, raised blood glucose level and obesity. These metabolic risk factors are also known as “intermediate risks factors,” which are strongly related to the occurrence of cardiovascular diseases. (WHO 2021). CVDs claimed the lives of 17.9 million individuals in 2019, accounting for 32% of all fatalities worldwide. Heart attacks and strokes account for 85 percent of these death (WHO 2021).

Somatotype has also been shown to be related to cardiovascular disease. An earlier study by Parnell (1959) found that the dominantly endo-mesomorphs have the highest risk of coronary thrombosis in their early middle life. This was followed by the mesomorphs. Individual with ectomorph somatotype, those with lean muscular builds had less risk. Individuals with somatotypes high in mesomorphy and endomorphy are at high risk for cardiovascular disease. Increased body weight has been associated with high coronary heart disease risk factor, which probably is reflected in increased endomorphy (Carter and Heath 1990). Later, in 2000, Williams et al. (2000) conducted a study regarding somatotype in patients with coronary artery diseases (CAD). They found that the body somatotype of the CAD patients were (5.7-5.6-1.4), indicated that they have dominant endomorphy and mesomorphy components. This study also found that somatotype was not significantly related to the angiography result. However, they found that endomorphy was significantly correlated with abdominal circumferences, the abdomen-to hip ratio and abdominal sagittal diameter, while mesomorphy was not related to these indicators of android or abdominal adiposity. Ectomorphy was found to be inversely related to the indices of general and regional adiposity. This study suggested that adiposity and muscularity were important features in increasing the CAD whereas, linearity was beneficial (Williams et al. 2000). In addition, a study conducted in Mexico discovered that people with type 2 diabetes had a somatotype with a major endomorphic and mesomorphic component, but a much reduced ecomorphic component (Urrutia-Garca et al. 2015).

In this study, blood cholesterol level, triglycerides, HDL, LDL and blood glucose of respondents were measured to assess their metabolic fitness as risk factors for cardiovascular diseases. Besides, this study also able to provide meaningful information on the important factors that contribute to the relationship between body somatotype components and cardiovascular diseases.

Material and Methods

This is a cross-sectional study of 308 adults from Kuala Terengganu to evaluate the body somatotype and risk factors to cardiovascular diseases. Based on the data from The National Health and Morbidity Survey (NHMS III), 2006, the prevalence of abdominal obesity among Malaysian adults is 17.4%. The estimated sample size needed was calculated based on the following formula (Daniel, 1999).

$n = Z^2 P (1-P) / d^2$

Where:

n = estimated sample size

Z = the standard value at confidence level at 95% = 1.96

P = the estimated prevalence based on the reported prevalence (17.4%) of abdominal obesity among Malaysian adults

= 17.4%

d = the margin of error is set at 5%

= 0.05

Therefore,

$N = (1.96)^2 \times 0.174 (1- 0.174) / (0.05)^2 = 220$

By taking into consideration of a 20% drop out rate (equivalent of 44 respondents), the sample needed was 264. A sample size of 264 respondents had to be recruited into this study based on the inclusion criteria already mentioned. The anthropometry measurements were taken for calculating body somatotype of respondents. Ten anthropometry data were measured in this study, namely weight, height, waist circumference, hip circumference, mid-arm circumference, triceps skinfold, subscapular skinfold, supraspinale skinfold, tight circumference, mid-tight skinfold, humerus breadth and femur breadth. All these measurement were then used for determining body somatotype among respondents by using the Heath and Carter method. To calculate endomorphy components, the equation below was used:

Endomorphy = $- 0.7182 + 0.1451(X) - 0.00068(X^2) + 0.0000014(X^3)$

Where,

X = (sum of triceps, subscapular and supraspinale skinfolds) multiplied by $\frac{170.18}{height\ in\ cm}$

This is called height-corrected endomorphy and is the preferred method for calculating endomorphy (Heath-Carter, 1990).

The equation to calculate mesomorphy is:

Mesomorphy = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height x (0.131) + 4.5

Three different equations were used to calculate ectomorphy according to the height-weight ratio:

a) If HWR is greater than or equal to 40.75, then ectomorphy = 0.732 HWR – 28.58.

b) However, if HWR is less than 40.75 but greater than 38.25, then ectomorphy = 0.463 HWR – 17.63

c) If HWR is equal to or less than 38.25, then ectomorphy = 0.1

Accuracy of the anthropometric measurement is very important in determining somatotype. The reliability is the extent to which results are consistent over time and an accurate presentation of the total population under same condition (Bordens and Abbott 2011). To ensure reliability, all anthropometric measurement is taken by a single trained anthropometrist. Other than that, a test-retest reliability of each anthropometric measurement were also conducted to make sure that there is no significant difference in mean of the two independent measures on the same subjects. Pearson correlation of the two measurements were also calculated, and the correlation were above 0.90.

To determine total cholesterol level, triglycerides, HDL cholesterol, LDL cholesterol, and blood glucose level among respondents, 5 ml fasting venous blood were obtained from them. They were asked to fast for 12 hours before the procedure and venous blood samples were taken by using standard procedure. Then, the blood samples were sent to Gribbles Pathology Lab, Kuala Terengganu for measuring the lipid profile and glucose level. Out of 308 respondents, total of 294 respondents voluntarily provided blood samples for analysis. This is because due to some drop out during the blood sampling process. To determine the blood glucose level and lipid profile, a fasting blood sample from vena puncture was taken from the subjects. The blood collection was done by following the venepuncture procedure (Clinical and Laboratory Standard Institute, 2007). For measuring blood glucose, blood samples were collected in sodium fluoride (grey) vacutainer tubes, and SST (gold) vacutainer tubes were used to collect blood for measuring the lipid profiles of respondents. Date and serial numbers were recorded on each tube.

Data management and treatment

Data from the questionnaire, anthropometric measurements and biochemical blood results were entered, computed and analysed using the Statistical Package for Social Science (SPSS) software version 20.0. For data treatment, including frequencies for all items was conducted to check missing data. Missing variable were corrected by rechecking the appropriate questionnaires. The level of significance was set at $p<.05$. Normality test was carried out to determine the distribution of the data. For the normally distributed data ($p> 0.05$), analysis were proceed by with the parametric test, while for not normally distributed data ($p<.05$), analysis were conducted with non-parametric test.

Statistical Analysis

The descriptive statistics such as the percentage, frequency, mean and median for sociodemographic profile, physical activity level, dietary intake, and blood glucose and profile lipid of respondents were presented.

One Way ANOVA was used to measure the difference in means of normally distributed data between more than two independent groups. The Pearson correlation was used to measure the relationship between two variables.

Ethical Consideration

Ethical approval that clarified the purpose of this study was obtained from the Universiti Sains Malaysia (USM) Ethical Committee (USMKK/PPP/JEPeM [237.4(1.11). Participants who consented to the study were informed of their rights to refuse participation or withdraw from the study if they wish to. Participants were guaranteed anonymity and all information provided was treated with confidentiality.

Results

Table 1 Mean (± sd) of Anthropometrics Measurement and Somatotype Components of Respondents (n=308)

Respondents characteristic	**Total (*n* = 308)**
Age (years)	38.18±5.23
Age range (years)	25-57
Mass (kg)	66.63±11.98
Height (cm)	160.21±9.60
BMI (kg/m^2)	26.09±5.69
Bone Width (cm):	
Humerus	6.06±0.66
Femur	8.56±0.84
Girth (cm):	
Biceps	31.16±4.17
Calf	37.20±4.53
Waist	80.08±10.00
Hip	96.66±8.14
Somatotype Components	
Endomorphy	7.21 ± 2.23
Mesomorphy	4.86 ± 1.49
Ectomorphy	1.12 ± 1.15

Table 2 Mean Endomorphy, Mesomorphy and Ectomorphy Components According to BMI Group of Respondents

Somatotype component	**Underweight (*n* = 6)**	**Normal (*n* = 128)**	**Overweight (*n* = 127)**	**Obese (*n* = 47)**	**p-value**
Endomorphy	2.54 ± 0.59	6.00 ± 2.14	7.76 ± 1.48	9.64 ± 1.00	0.000
Mesomorphy	1.64 ± 1.12	3.91 ± 1.01	5.20 ± 0.91	6.94 ± 1.02	0.000

Ectomorphy	5.14 ± 0.77	1.93 ± 0.89	0.48 ± 0.36	0.10 ± 0.00	0.000

Notes. One way ANOVA: Significant level at p < .05; *n* = 308

Table 3 Mean Glucose Level and Lipid Profiles Among Respondents

Blood Glucose and Lipid profile	Total respondents (*n* = 294)
Glucose (mmol/L)	5.01 ± 0.58
Cholesterol (mmol/L)	5.55 ± 0.99
Triglycerides (mmol/L)	1.57 ± 0.81
HDL-cholesterol (mmol/L)	1.25 ± 0.30
LDL-cholesterol (mmol/L)	3.61 ± 0.92

Table 4 Mean Blood Glucose Level and Lipid Profiles Among Respondents Based on Dominant Body Somatotype Categories

Glucose & Lipid profile	Somatotype categories			p- value
	Endomorph (*n* = 250)	Mesomorph (*n* = 33)	Ectomorph (*n* = 11)	
Blood glucose (mmol/L)	5.03 ± 0.58	4.95 ± 0.57	4.75 ± 0.46	0.196
Cholesterol (mmol/L)	5.57 ± 0.93	5.51 ± 1.34	5.00 ± 0.81	0.169
Triglycerides (mmol/L)	1.55 ± 0.82	1.67 ± 0.74	1.45 ± 0.73	0.667
HDL-cholesterol (mmol/L)	1.25 ± 0.29	1.23 ± 0.31	1.34 ± 0.34	0.527
LDL-cholesterol (mmol/L)	3.63 ± 0.87	3.61 ± 1.28	2.94 ± 0.68	0.049*

Notes. One Way ANOVA. *Significant at p < .05; *n* = 294

Table 5 Correlation Between Each Somatotype Component and Lipid Profiles among respondents

Risk factors	Endomorphy		Mesomorphy		Ectomorphy	
	r	p	*r*	p	*r*	p
Cholesterol	0.063	0.280	0.109	0.062	-0.117	0.045*
LDL-cholesterol	0.094	0.109	0.127	0.029*	-0.143	0.014*
HDL-cholesterol	-0.100	0.045*	-0.073	0.213	0.123	0.035*
Triglycerides	-0.085	0.146	0.063	0.283	-0.057	0.326
Blood glucose	0.295	0.035*	0.096	0.101	-0.141	0.016*

Notes. Pearson correlation. *Significant at p < .05

Discussion

Characteristic, Anthropometric Measurements and Somatotype Components Score Among Respondents

Table 1 shows that the mean age and anthropometric characteristics of the respondents. Mean age of respondents was (38.18 ± 5.23) years. Their ages ranged between 25 years and 57 years. In terms of weight, the respondents weighed (66.63 ± 11.98) kg. The BMI of respondents was (26.09 ± 5.69) kg/m^2, which indicated that they were in the overweight category (WHO 1998). Four skinfolds, two bone breadth and four girths were measured. These data were then used to calculate body somatotype of the respondents following the Heath-Carter somatotype method.

Mean of three somatotype components, namely endomorphy, mesomorphy and ectomorphy among subjects were presented in Table 1. Endomorphy is relative fatness, while ectomorphy is musculoskeletal robustness relative to height and ectomorphy refers to relative linearity of the body. The mean somatotype of all respondents in this study was (7.21, 4.86, 1.12). According to Heath and Carter (1990), these respondents belonged to mesomorphic endomorph somatotype category. Based on the definition in the manual, mesomorphic endomorph somatotype is when the score of endomorphy is dominant, and mesomorphy score is greater than ectomorphy (Heath and Carter, 1990).

The mean endomorphy component of the respondents was (7.21 ± 2.23). A score of 5.5 to 7.5 on endomorphy component means that the subjects have high relative fatness. They have thick subcutaneous fat, roundness of trunk and limbs and have increased storage of fat in the abdomen. The mean mesomorphy component of respondents was (4.86 ± 1.49). It indicated that respondents had moderate relative musculoskeletal development and had increased muscle bulk and thicker bones and joints (Heath and Carter 1990). The mean score of ectomorphy component among respondents was (1.12 ± 1.15). This showed that respondents of this study had low linearity physique, had great bulk per unit height, were rounded in shape and had relatively bulky limbs (Heath and Carter, 1990).

Somatotype Components of Respondents According to BMI Categories of Respondents

Table 2 presents the endomorphy, mesomorphy and ectomorphy components across the BMI categories. Obese respondents had highest endomorphy score, while underweight respondents had the lowest endomorphy score ($p < .05$). Endomorphy score was observed as increasing with BMI among respondents ($p < .05$).

Mesomorphy score was also observed as highest among obese respondents, and lowest among underweight respondents ($p < .05$). Mesomorphy components also increased with BMI among respondents ($p < .05$). Ectomorphy score was highest among underweight respondents, and lowest in obese respondents. Ectomorphy score decreased with BMI among them ($p < .05$).

Blood Glucose and Lipid Profile among Respondents

Table 3 shows the (mean ± sd) of blood glucose, cholesterol, triglycerides, HDL and LDL cholesterol levels among all respondents. The mean blood glucose level of respondents was (5.01 ± 0.58) mmol/L. The fasting blood glucose levels of respondents were in the normal ranges for blood glucose (American Diabetes Association 2016). The mean cholesterol level among respondents was (5.55 ± 0.99) mmol/L. According to the National Cholesterol Education Program (NCEP 2001), the cholesterol level of respondents of this study can be considered as on the borderline high (range = 5.17 to 6.19 mmol/L).

The mean fasting triglycerides level among respondents was (1.57 ± 0.81) mmol/L. Based on the NCEP (2001), it can be considered as on the borderline high. (The mean HDL cholesterol level of all respondents was 1.25 ± 0.30 mmol/L. According to the NCEP (2001), the level of HDL cholesterol ≥ 1.55 mmol/L is desirable. The level of fasting LDL cholesterol among respondents in this study was (3.61 ± 0.92) mmol/L, indicating that the LDL levels among all respondents in this study were on the borderline high according to the guidelines of the (NCEP 2001).

Table 4 shows the mean blood glucose level and lipid profile among all respondents based on dominant body somatotype categories. There is a significant difference in LDL cholesterol levels among respondents based on their body somatotype categories. LDL was highest among endomorph subjects (3.63 ± 0.87) mmol/L and lowest among ectomorph subjects (2.94 ± 0.68) mmol/L. According to the (NCEP, 2001), the levels of LDL among endomorph and mesomorph subject were on the borderline high, while ectomorph subjects were above the optimal level. However, Table 4 also shows that no significant difference were observed in blood glucose level and other lipid profiles of subjects based on dominant body somatotype categories among respondents (p > .05). These suggested that the circulating lipids in the body are directly influenced by the level of fatness in the body. It has been frequently reported that obesity is weakly but significantly associated with total cholesterol, triglycerides and LDL cholesterol and inversely with HDL cholesterol (Petridou et al. 1995). Besides, many research have shown that individual with higher percentage of fat in the body have poorer lipid profiles (Freedman et al. 1999 , Plourde 2002).

Relationship between Body Somatotype and Risk Factors of Cardiovascular Diseases among Respondents

Relationship of the three somatotype components, namely endomorphy, mesomorphy and ectomorphy with risk factors of cardiovascular diseases such as total blood cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and glucose level were also investigated in this study were presented in Table 5.

Only ectomorphy components of respondents shows significant negative correlation with blood cholesterol level (r= - 0.117, p= 0.045). This indicated that when ectomorphy components score of respondents increase, blood cholesterol of respondents decrease and vice versa. LDL cholesterol of respondents correlates significantly with mesomorphy and ectomorphy components, but not endomorphy components among respondents. LDL cholesterol increase with increase of mesomorphy score of respondents (r=0.127, p=0.029), while it decrease with the increment of ectomorphy score of respondents (r= -0.143, p= 0.014) and vice versa.

HDL-cholesterol level shows inverse relationship with endomorphy component score among respondents (r= -0.100, p=0.045), indicating that levels of HDL cholesterol decrease when endomorphy component score decrease, however HDL cholesterol shows parallel relationship with ectomorphy components (r=0.123, p=0.035), indicating that HDL cholesterol increase with increase of ectomorphy component's score and vice versa. There were no significant correlation exist between triglycerides level with all the three somatotype component namely endomorphy, mesomorphy and ectomorphy among respondents (p>0.05).

Blood glucose level did not show any significant relationship with mesomorphy components, but have positive correlation with endomorphy components score among respondents (r= 0.295, p=0.035) indicating that glucose level will increase with increment of endomorphy score among respondents and vice versa. However, it shows negative correlation with ectomorphy components (r= -0.141, p= 0.016) which indicated that blood glucose will decrease with the increment of ectomorphy components score.

In term of the direction of correlation, endomorphy correlates directly with blood glucose level but have inverse relationship with HDL cholesterol level. Mesomorphy only show positive correlation with LDL cholesterol level, while endomorphy show negative correlations with blood cholesterol, LDL cholesterol and blood glucose level but have positive correlation with HDL cholesterol level of respondents.

Based on the result obtained, there were significant weak relationships between each somatotype components namely endomorphy, mesomorphy and ectomorphy to the lipid profiles among respondents in this study (correlation coefficient ranged between -0.143 to +0.295). Beside somatotype, there are many other factors that may be associated with lipid profiles level such as component in diet such as consumption of trans-fatty acid and animal protein, age, gender, obesity, genetics, physical activity and medical conditions (Whitney and Rofles 2012, Cugnetto et al. 2007)

Not many studies have been done to relate somatotypes to specific risk factors for cardiovascular disease. In a study by Malina et al. (1997) to determine the relationships between somatotype and cardiovascular risk factors in healthy adults in French Canada, they found that body type was weakly associated with common cardiovascular risk factors in healthy men and women(ranged between r= -0.20 to +0.30). This is consistent with the findings in our study, where we also found that there was only a weak correlation between each somatotype components and lipid profiles. The pattern of correlation in their study also parallel with the pattern of correlation in our study, where we found that endomorphy were positively associated with most lipid profiles and ectomorphy were found to have negative correlation with most lipid profiles components. Boluncuk et al. (2000) also shows similar pattern of correlation between each somatotype components and lipid profiles. Similar to our study, they found that endomorphy component have a positive correlation with triglycerides and also LDL cholesterol, and negative correlation with HDL cholesterol level. A study by Gertler et al. (1950) indicated that there was higher correlation between endomorphy and blood cholesterol. However, analysis in the present study could not find any correlations between endomorphy and blood cholesterol. This finding is in agreement with the findings of Bolonchuk et al. (2000), but in contrast with results reported by Tanner et al. (1960), Allard and Goulet (1968), Gordon et al. (1987) and Malina et al. (1997). Several investigations have shown the existence of an association between somatotype components and cardiovascular diseases (Herrera et al. 2004).

Conclusion

This study explored the somatotype characteristics and examined the association between lipid profiles with each somatotype components among government employees in Kuala Terengganu. Somatotype of respondents were also different according to BMI categories. Endomorphy and mesomorphy components increased with BMI, while ectomorphy decreased with BMI. Among respondents with normal BMI, it was found that they have high endomorphy score. This indicated that, even though they have normal BMI, however they have extremely high relative fatness in subcutaneous and also abdominal fat. This suggested that using BMI alone cannot distinguished the hidden fat in the body. Thus, we suggested that in spite of using BMI as tools to measure fatness, the somatotype method should be also used as it is a more sensitive method to measure body fatness in individuals. There were weak correlations between lipid profiles with each somatotype components, namely endomorphy, mesomorphy and ectomorphy. The correlation coefficient between total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides and glucose ranged between (-0.143 to +0.295). Generally it can be concluded that there were only small association between lipid profiles with body somatotypes among respondents in this study.

Referencias

Allard C., Goulet C. (1968). Serum lipids: an epidemiological study of an active Montreal population. *Canadian Medical Association Journal*, 98(13):627-637.

Beashel P., Taylor J. (1997). Fitness for Health and performance. *The World of Sport Examined*, p 55.

Bolonchuk W. W., Siders W. A., Lykken G. I., Lukaski H. C. (2000). Association of dominant somatotype of men with body structure, function during exercise, and nutritional assessment. *American Journal of Human Biology*, 12(2): 167-180.

Bordens K. S., Abbott B. A. (2011). A process approach to research design and methods.

5.Brayton, C., Treuting P. M. (2012). Phenotyping. In Comparative Anatomy and Histology. Elsevier Inc.

Carter J.E. L., Heath B. H. (1990). Somatotyping: development and applications, Cambridge University Press.

Carter J.E.L. (2002). The heath-carter anthropometric somatotype-instruction manual. San Diego, USA.

Clinical and Laboratory Standard Institute. (2007). Procedures for the collection of diagnostic blood specimens by venipuncture; approved standard. Clinical and Laboratory Standards Institute, 27(26): CLSI.

Cugnetto M. L., Saab P. G., Llabre M. M., Goldberg R., McCalla J. R., Schneiderman N. (2007). Lifestyle factors, body mass index, and lipid profile in adolescents. *Journal of pediatric psychology*, 33(7): 761-771.

Daniel W. W. Biostatistics. A Foundation for analysis in the Health Sciences. 1999. Hoboken: Wiley.

Eckel R. H., Kahn R., Robertson R. M., Rizza R. A. (2006). Preventing cardiovascular disease and diabetes A call to action from the American Diabetes Association and the American Heart Association. *Circulation*, 113(25): 2943-2946.

Elia M. (2001). Obesity in the elderly. *Obesity research*, *9*(S11): 244S-248S https://doi.org/10.1038/oby.2001.126
Expert Panel on Detection, Evaluation. (2001). Executive summary of the Third Report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). *Jama*, 285(19): 2486.

Freedman L. S., Midthune D., Carroll R. J., Krebs-Smith S., Subar A. F., Troiano R. P., Kipnis V. (2004). Adjustments to improve the estimation of usual dietary intake distributions in the population. *The Journal of nutrition*, 134(7): 1836-1843.

Gakhar I., Malik S. L. (2002). Age changes and sex differences in somatotypes among Jats of Delhi. *Anthropol Spec Issue* 1, 115-125.

Gertler M. M., Garn S. M., Sprague H. B. (1950). Cholesterol, Cholesterol Esters and Phospholipids in Health and in Coronary Artery Disease II. Morphology and Serum Lipids in Man. *circulation*, *2*(3): 380-391.

Gordon E., Tobias P. V., Mendelsohn D., Seftel H., Howson A. (1987). The relationship between somatotype and serum lipids in male and female young adults. *Human biology*, 59(3): 459-465

Heath B. H. (1963). Need for modification of somatotype methodology.*American journal of physical anthropolog*, 21(2): 227-233.

Herrera H., Rebato E., Hernandez R., Hernández-Valera Y., Alfonso-Sanchez M. A. (2004). Relationship between somatotype and blood pressure in a group of institutionalized Venezuelan elders. *Gerontology*, 50(4): 223-229.

IPH (Institute for Public Health) (2008). The Third National Health and Morbidity Survey (NHMS III) 2006, General Findings. Ministry of Health Malaysia,Kuala Lumpur.

Jonsson S., Hedblad B., Engström G., Nilsson P., Berglund G., Janzon, L. (2002). Influence of obesity on cardiovascular risk. Twenty-three-year follow-up of 22,025 men from an urban Swedish population. *International journal of obesity and related metabolic disorders: journal of the International Association for the Study of Obesity*, 26(8): 1046-1053.

Malina R. M., Katzmarzyk P. T., Song T. M., Theriault, G., Bouchard, C. (1997). Somatotype and cardiovascular risk factors in healthy adults. *American Journal of Human Biology*, *9*(1):11-19.

Mozumdar A., Roy S. K. (2008). Somatotype of the individuals with lower extremity amputation and its association with cardiovascular risk. *Anthropologischer Anzeiger*, 66(1):99-116.

Norton K., Olds T. (Eds.). (1996). Anthropometrica: a textbook of body measurement for sports and health courses. UNSW press.

Parnell R. W. (1959). Physique and family structure. *The Eugenics review*, 51(2): 75-88.

Petridou E., Malamou H., Doxiadis S., Pantelakis S., Kanellopoulou G., Toupadaki N., Trichopoulos D. (1995). Blood lipids in Greek adolescents and their relation to diet, obesity, and socioeconomic factors. *Annals of Epidemiology*, *5*(4): 286-291.

Rafter N. (2007). Somatotyping, antimodernism, and the production of criminological knowledge. *Criminology*, 45(4): 805-833.

Rosenbaum R. (1995). The great Ivy League nude posture photo scandal. New York Times, 15, 28.

Schulte H., Cullen P., Assmann G. (1999). Obesity, mortality and cardiovascular disease in the Münster Heart Study (PROCAM). *Atherosclerosis*, 144(1): 199-209.

Sheldon W. H., Stevens S. S., Tucker W. B. (1940). The varieties of human physique.

Singh S. P. (2007). Somatotype and disease–A review. *Anthropologist*, 3: 251-61.

Tanner J. M., Israelson W. J., Whitehouse R. H. (1960). Physique and body composition as factors affecting success in different athletic events. *Journal of Sports Medicine and Physical Fitness*, 14: 397-411.

Thomas F., Bean K., Pannier, B., Oppert J. M., Guize L., Benetos A. (2005). Cardiovascular Mortality in Overweight Subjects The Key Role of Associated Risk Factors. *Hypertension*, 46(4): 654-659.

Urrutia-García K., Martínez-Cervantes T. J., Salas-Fraire O., Guevara-Neri N. P. (2015). Somatotype of patients with type 2 diabetes in a university hospital in Mexico. *Medicina Universitaria*, 17(67): 71-74.

Valkov J., Matev, T., Hristov I. (1996). Relationship between somatotype and some risk factors for ischemic heart disease. *Folia medica*, 38(1): 17-21.

Whitney E., Rofles S.R (2012). Understanding Nutrition. Nelson Education.

Williams S. R., Goodfellow J., Davies B., Bell W., McDowell I., Jones E. (2000). Somatotype and angiographically determined atherosclerotic coronary artery disease in men. *American Journal of Human Biology*, 12(1): 128-138.

World Health Organization. (2021). Cardiovascular diseases (CVDs). [Fact Sheet Cardiovascular diseases] https://www.who.int/health-topics/cardiovascular-diseases#tab=tab_1

Acknowledgement

The authors would like to express their gratitude to all the respondents for their participation, full cooperation, and patience with the study.

Conflict of interest

The authors do not have any conflicts of interest to declare.

About the License