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Ethnic and Gender Variations in The Trunk-To-Leg Ratio Among Malaysian Adults in Shah Alam Population

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ABSTRACT: ***Background and Aim:*** Definite and proportional biological relationship of the trunk to leg is specific which makes either of it suitable to be used during examination of incomplete and dismembered bodies. The ratio of the trunk to leg is an important information that help in identification of age, sex, and race. The aim of this study is to investigate the relationship between trunk-to-leg ratio and gender among the three major ethnic groups in Malaysia. ***Methodology:*** The current research included 270 young adults (18-35 years old) from both gender and three major ethnic groups (Malay, Indian & Chinese) in Shah Alam, Selangor. The mean and standard deviation of the measurements taken were calculated. Pearson's correlation coefficient and linear regression equations were calculated for all participants then for each gender. ***Results:*** This is a statistically significant gender and ethnic differences between the length of trunk (TL) and length of leg (LL) ratio ($p>0.01$) among the studied sample of Malaysian. Both TL and LL showed a moderately strong correlation ($r=0.45$). ***Conclusion:*** The mean and the ratio of both TL and LL measurement is higher in males than in female subjects in the study group and TL shows a strong correlation with the height while LL does not.

Keywords: Trunk Length, Leg Length, Ratio, Forensic Examination, Regression Equation.

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INTRODUCTION

Anthropometry, the scientific study of human body measurements, serves as a critical tool for understanding physical diversity and its implications for health and wellness.[1] Research has indicated that body shape metrics, such as the trunk-to-leg ratio, can provide valuable insights into health outcomes, including metabolic syndrome and mortality rates. For instance, a higher trunk-to-leg volume ratio has been associated with increased risks of diabetes and cardiovascular diseases, highlighting the importance of this metric in public health assessments.[2] Moreover, variations in body proportions among different ethnicities can influence these health risks, necessitating a nuanced understanding of how these factors interact within specific populations.[3]

Malaysia is one of the fast-developing countries in Southeast Asia. According to ministry of Economics, department of statistics Malaysia, there are 35 million of populations in Malaysia.[4] The economic growth and technological improvements will lead to a greater demand and development of machines and devices used in industrial and non-industrial settings and this would result in a greater interaction between man and machines. Therefore, in order to achieve a suitable interaction between man and machines, anthropometric data is one of the essential factors in designing machines and devices.[5] However, anthropometric data for the Malaysian population are limited especially involving young adult's population and children. This probably due to the fact that the anthropometry survey is quite expensive, time consuming and the availability of

other Asian anthropometry data which is considered as equivalent.[6]

In Malaysia, where the population comprises, diverse ethnic groups including Malays, Chinese, and Indians, previous studies have documented significant variations in body composition and physical characteristics.[7] For example, a comprehensive anthropometric study revealed that ethnic variations significantly affect body shape and size, which may correlate with lifestyle factors such as diet and physical activity levels.[8]

Due to lack of detailed anthropometric data, it is difficult to predict a model of Malaysian young adults and have to rely on data from other Asian countries. Moreover, Malaysia is a country with diverse cultures and ethnic groups with three major ethnic groups (Malay, Chinese and Indian). Thus, the anthropometric measurement such as the ratio of trunk to leg of Malaysian young adults observed to be varying or similar owing the variation of gender and ethnic group in the population. Furthermore, Trunk-Leg ratio (TLR) or Leg-to-trunk ratio (LTR) is the ratio of leg length and trunk length (the large value of TLR indicates a large leg length for given body height). TLR is obtained by dividing leg length by sitting height because the leg length is calculated as the difference between height and sitting height. Leg length is a marker of environmental influences on childhood growth before puberty as, up until puberty, and height increase are mostly attributed to leg growth.[9]

This study aims to explore the anthropometric differences that exist across various ethnic groups and genders within the Malaysian adult population. This research is particularly relevant in urban centers like Shah Alam, where rapid socio-economic changes may further influence these anthropometric measures.[10] By focusing on the trunk-to-leg ratio and its ethnic and gender variations among adults in Shah Alam, this study aims to fill existing gaps in the literature regarding Malaysian anthropometry. The findings could have practical implications for health interventions and tailored public health policies that address the unique needs of different demographic groups within Malaysia.

METHODS

This is a cross-sectional research design studies the correlation between trunk to leg ratio by using a physical measurement among young adults as they exist in a defined population at the present moment, which is suited for this research. This study was conducted in Shah Alam, Selangor among the young adults who are in the age range of 18-35 who are resting or working in Shah Alam, Selangor. The sample size needed for the current study was calculated using the single population proportions formula as 270 participants including both genders and the three major ethnic groups of the Malaysian population. Participants who are eligible to join this research must be physically normal (height, trunk length and leg length), have no underlying diseases and residing in Shah Alam, Malaysian nationality respondents with ethnic groups of Malay, Chinese and Indians.

The sampling method that was used for this study is non proportional quota sampling, which falls under the subcategory of the purposive nonprobability sampling method. In this research, the data will be measured manually. Tools used were anthropometer rod, measuring tape, paper, pen or pencil and the real height chart. Collection of data for this study is approved by the Research and Ethnic Committee of the International Medical School (IMS), MSU. They were given a consent form to attain their written consent. These participants were assured of confidentiality, and that the data was used for research purposes only.

RESULTS

Among the studied group of Malaysian population, the mean height (cm) of male subjects is significantly higher (177.50+12.10) as compared to female subjects (159.80+6.18). The mean and median values of TL and LL are higher for males than those for females (Table 1).

Table 1: Gender Comparison of Height, Trunk Length (TL) and Leg Length (LL) Among the Study Participants

Variable	Male		Female		P-	Ratio
(cm)	Median	Mean±SD	Median	Mean±SD	value	(%)
Height	175	177.50±12.10	157	159.80±6.18	0.03	90
TL	48	47.03±4.54	38	40.18±5.72	0.255	85
LL	103.2	103.82±10.50	83.82	82.64±4.71	0.616	79

Table (2) is showing that the mean height (cm) in Malay subjects is significantly higher (168.83±6.33) as compared to Indian subjects (168.61±12.29) and Chinese subjects (168.12±13.17). Besides, the difference of height between Malay, Chinese and Indian subjects found statistically significant in this study (p=0.02). Moreover, the mean of TL is significantly higher (45.23±5.07) in Chinese subjects as compared to Malay subjects (42.93±6.33) and Indian subjects (42.67±6.79). Although, the mean of LL in Indian subjects is found higher (94±15.21) as compared to Malay subjects (91.90±11.76) and Chinese subjects (93.59±12.73). However, the difference is found to be statistically significant for TL (p<0.001) and LL (p<0.001).

Table 2: Ethnic variations of height, trunk length (TL) and leg length (LL) among the study participants.

variable	Malay		Chinese		Indian		P-	Ratio
(cm)	Median	Mean±SD	Median	Mean±SD	Median	Mean±SD	value	(%)
Height	165	168.83±6.33	166.50	168.12±13.17	167	168.61±12.29	0.02	99
TL	42.50	42.93±6.33	45.72	45.23±5.07	40.64	42.67±6.79	<0.001	43
LL	88.90	91.90±11.76	90	93.59±12.73	86.87	94±15.21	<0.01	93

From the results in table (3), it is observed that the correlation between the height and both TL (p<0.001) and LL (p=0.02) among the study population is statistically significant. In term of the strength of correlation, the TL is the strongest correlation with the height (r=0.189) meanwhile LL has less correlation with the height (r=0.02) among the study population.

Table 3: Correlation Study of Height with the Trunk Length (TL) and Leg Length (LL) Among the Study Participants.

variables	Height	
(cm)	p-value	r-value
TL	<0.001	0.189
LL	0.02	0.020

Figure 1 shows the linear regression and correlation of the TL and height among the total study population (n=270) including all the three major ethnic groups and both genders. It is observed that the scatter plot is very statured, and it is described the distribution of height and TL among the study population were highly close to each other. However, the graph shows a positive string correlation between TL and height. Figure (2.1) is showing the linear regression and correlation of the TL and height among males of this present study (n=135) including all the three major ethnic groups. From the observation, the scatter plot shows a negative correlation between TL and height.

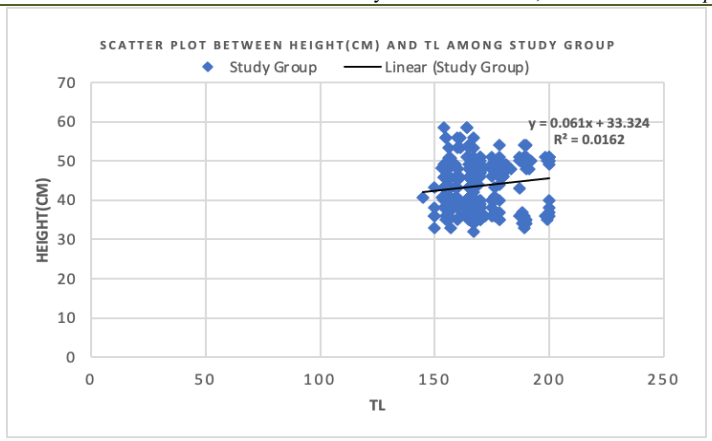

Figure 1: Scatter plot between Height (cm) and TL among study group.

Figure 2.1: Scatter plot between height (cm) and TL among Males.

Figure (2.2) is showing the linear regression and correlation of the TL and height among female subjects in this present study (n=135) including all the three major ethnic groups. From the observation, the scatter plot shows a positive correlation between TL and height. It is described the distribution of height and TL among females in the study population were close to each other.

Figure (3.1) is showing the linear regression and correlation of the LL and height among male subjects in the present study population (n=135) including Malay, Chinese and Indian ethnic groups. The scatter plot shows a negative correlation between LL and height. It is described the distribution of height and LL among males in the study population were not close to each other.

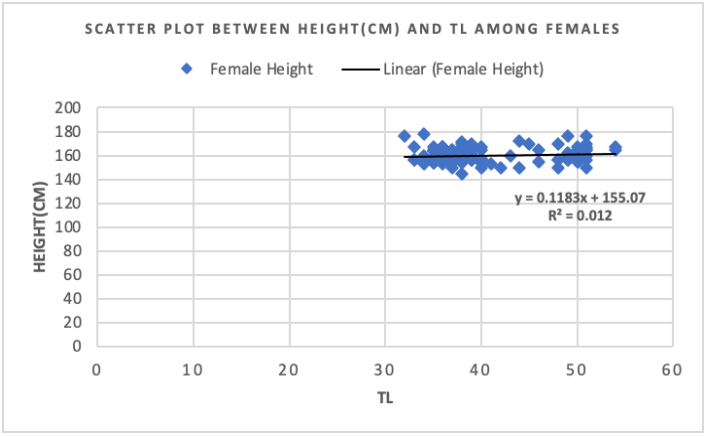

Figure 2.2: Scatter Plot Between Height (cm) and TL Among Females

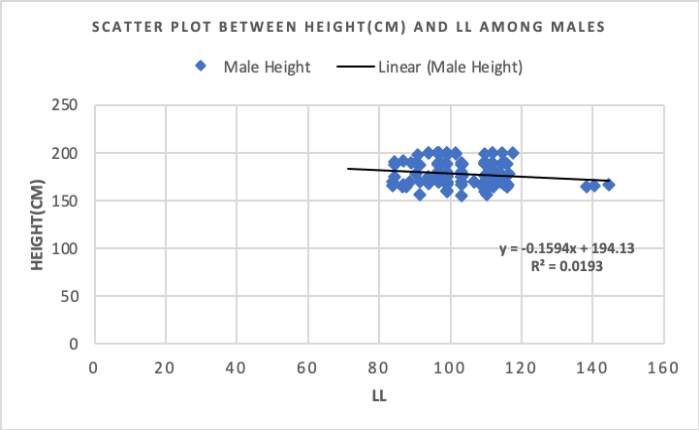

Figure 3.1: Scatter plot between height (cm) and LL among Males

Figure (3.2) is showing the linear regression and correlation of the LL and height among females in the study population (n-135) including Malay, Chines and Indian ethnic groups. Based on the observation, the scatter plot shows a positive correlation between LL and height where it is described the distribution height and LL among the females were close to each other. Regression equation was derived from the total study population and then for either gender separately (Table 4).

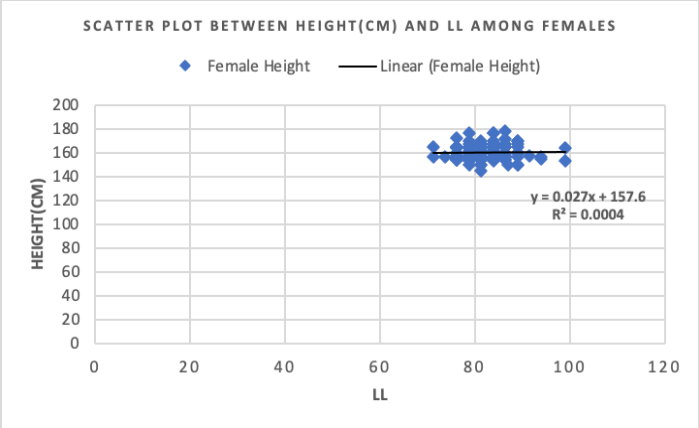

Figure 3.2: Scatter Plot Between Height (cm) and LL Among Females.

Table 4: Regression Equation for TL and LL Among the Study Group

Parameters	Total	Male	Female
TL	y=0.061x + 33.324	y=-0.0986x + 182.22	y=0.1183x + 155.07
LL	y=-0.1986x + 187.1	y=-0.1594x + 194.13	y=0.027x + 157.60

DISCUSSION

The present study is an attempt to create a database for the anthropometric measures for the Malaysian young adults for the height and the ratio of trunk length and leg length with a future expectation to help during designing a specifically suited products, equipment and living facilities in order to achieve an ergonomically designed human machine interaction.[5] Previous research has studied the relationship between TL and human diseases; risks factors and effects. Nevertheless, very few explored the new anthropometry database measurement especially in Malaysia.[11] So, this study was aimed to evaluate the relationship between height, trunk length and leg length among young adults in Malaysia with three different ethnic group and gender. The findings of this study highlight significant ethnic variations in height, trunk length (TL), and leg length (LL) among Malaysian adults in Shah Alam. These variations can be attributed to a combination of genetic, environmental, and socio-cultural factors.[12]

Chinese subjects exhibited a significantly higher mean TL compared to Malay and Indian

subjects. This finding is consistent with studies that suggest ethnic differences in body proportions, where East Asian populations tend to have longer trunks relative to their legs.[13] These differences in body proportions can influence various health outcomes, including the risk of certain diseases and physical performance. Interestingly, Indian subjects had a higher mean LL compared to Malay and Chinese subjects. This observation is supported by research indicating that South Asian populations generally have longer legs relative to their trunks. Leg length has been associated with various health indicators, including cardiovascular health and metabolic risk factors.[14] These findings have important implications for public health and clinical practice. Understanding ethnic variations in body proportions can aid in the development of more tailored health interventions and nutritional guidelines. Additionally, these variations should be considered in ergonomic designs and clothing manufacturing to better cater to the diverse population in Malaysia. On the other hand, in 2011, both Asha and Lakshmi had conducted a study among males and females in South and North India. All the studied parameters showed significant gender differences, but there was no statistically significant difference between South and North Indian population that may reach the conclusion that among persons of the same gender from different population groups, geographical variation does not have many influences on body proportions.[15] The results of this study reveal significant correlations between height and both trunk length (TL) and leg length (LL) among the study population. The correlation between height and TL ($p<0.001$) is stronger than that between height and LL ($p=0.02$), with correlation coefficients of $r=0.189$ and $r=0.02$, respectively. This indicates that TL has a more substantial influence on height compared to LL in the study population. Studying the linear regression and correlation between TL and height for the entire study population (n=270), including all three major ethnic groups and both genders, the scatter plot shows a positive correlation, suggesting that as TL increases, height also tends to increase. This positive correlation aligns with existing literature that highlights the importance of trunk length in determining overall height.[16] For males, the scatter plot indicates a negative correlation, which is somewhat unexpected and may warrant further investigation. In contrast, the scatter plot for females shows a positive correlation, consistent with the overall population trend. This gender difference in correlation patterns could be influenced by various factors, including genetic and environmental differences.[17]

Studying the linear regression and correlation between LL and height showed that among males, the scatter plot shows a negative correlation, indicating that as LL increases, height does not necessarily increase proportionally. This finding contrasts with the positive correlation observed among females, where the distribution of height and LL is closely aligned. A study on the Igbo population of Nigeria detected significant correlations between the measurements of the body height and lower extremity. The study reported that LL had a significant correlation with height in females but not in males.[18] Research on the relationship between height and body mass index (BMI) in adults found that height and BMI are inversely related, with the correlation being more pronounced in women than in men. This study highlights the importance of considering gender differences when examining the relationship between height and body proportions.[17]

A study on the prediction of body height using tibial length (TL) in children with cerebral palsy demonstrated a strong correlation between TL and height. The study developed predictive equations that were accurate across different age groups and genders, emphasizing the utility of TL as a predictor of height.[19] Each race and age group requires its own table.[20] Therefore, the equations retrieved from this research are specifically applicable to Shah Alam population only.

CONCLUSION

In the present study, the mean height of males is higher than females with a statistically significant gender differences ($p=0.03$) while, the mean of both TL and LL is higher in males than females but it is not statistically significant for both TL ($p=0.255$) and LL (p-0.6160), while the difference of height between the three major ethnic groups is statistically significant ($p=0.02$). Trunk length (TL) showed the strongest correlation with height meanwhile limb length (LL) showed the lowest correlation with height. The regression formulae to estimate TL and LL derived in the present study have the potential of use in medico-legal case investigations or anthropological studies. However, these formulae are applicable to the studied population only due to inherent variations and

environmental factors such as climate and nutrition. Overall, the study is helpful during certain untoward circumstances such as a natural disaster, accident or murders in Malaysia or even in the other countries, that where to identify the individual of Malaysian young adults.

In conclusion, this study highlights the significant correlations between height and both TL and LL in a diverse population. The stronger correlation between TL and height suggests that trunk length plays a more critical role in determining overall height compared to leg length. Gender-specific analyses reveal differing patterns of correlation, with females showing positive correlations for both TL and LL, while males exhibit a negative correlation for LL.

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