Asian Social Science
www.ccsenet.org/journal.html
Vol. 5, No. 6
June 2009

Anthropometry Dimensions of Older Malaysians: Comparison of Age, Gender and Ethnicity

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Abstract

Studies have indicated that body dimensions differ for various populations. To determine whether there are differences in the anthropometric data of the elderly population in Malaysia, the anthropometric data collected from a previous project was used. These comparisons can give some indications of the relative sizes between age, gender and ethnicity in Malaysian elderly populations. The results showed that some anthropometric dimensions were influenced by age, gender and ethnicity. Regression analysis showed that age and ethnicity were significant predictors ($p < .01$) of Malaysians elderly BMI's. The analysis has provided important information in designing and planning of facilities and products for elderly populations.

Keywords: Anthropometry dimensions, Older Malaysians, BMI's, Demographic background

1. Introduction

The population of today's world is rapidly ageing. Elderly populations have grown because of worldwide improvements in health services, educational status, and economic development (Kinsella & Victoria, 2001). The number of persons aged 60 years or over is estimated to be 688 million in 2006 and is projected to grow to almost 2 billion by 2050 (United Nations, 2006). Even though Malaysia's population is not currently aged, this will change over the next two decades. Malaysia is expected to increase its percentage of older persons to more than 7% in 2010 and 9.8% in 2020 (Pala, 1998).

With increasing ageing trends, it is necessary to consider older people's cognitive strengths, capabilities and physical limitations in the planning or design of products for daily use. Therefore, their anthropometric characteristics must be quantified. Besides, anthropometric measurements are also important indicators of an individual nutritional status. The ageing process involves modifications in nutritional and physiological status, such as a decrease in body weight and height (Dey et al., 1999) and also a declining in fat-free mass associated with an increase in fat mass. Body composition changes occur differently in males and females and in the various phases of ageing, influencing anthropometry. Consequently, the anthropometric standard values derived from adult population may not be applicable to the elderly.

There is very little information about anthropometric data of older persons, especially in developing countries. Only more recently have population studies included specific data on individuals 75 years of age and older (Kuczmarski et al., 2000; Perissinotto et al., 2002; Velasquez-Alva et al., 2003; Santos et al., 2004). Fozard (1981) and Stoudt (1981) have pointed out that older people differ anthropometrically with inter-individual variance increasing with age. Hence anthropometric data available for younger generation cannot be used even with allowances for the age-related changes for the elderly population. Another complicating factor is the ethnic mix, which could be very different in the elderly population compared to the young adult population.

Since Malaysia is a multi-racial, multi-ethnic country, comparison of the anthropometric dimensions between its populations is useful. Age, gender and ethnicity differences of anthropometric dimensions of the Malaysians elderly will not only help to explain the ageing process of each group, but also to determine the group at risk and thus, attention can be directed to this group.

2. Methodology

In this study, 39 body dimensions of 230 older Malaysians comprising males (N=129) and females (N=101) and Malays (N=174) and non-Malays (N=56) were obtained from an earlier study entitled 'An Elderly Friendly Housing Environment for Older Malaysians' by the Institute of Gerontology, Universiti Putra Malaysia. Body mass Index (BMI,

weight/height²) was calculated and categorized from same data into four groups (underweight, normal, overweight and obesity) using the World Health Organization (WHO) standard method. The BMI represents the easiest and most frequently used index to identify subjects at risk for under-or over-nutrition. Data was analyzed using Statistical Package for the Social Sciences (SPSS). Level of significance used for the data was set at $p<0.05$ (two-tailed).

2.1 Comparisons were made for anthropometry and Body Mass Index (BMI) between:

i. Males(m) and females (f)

ii. Malays(ma) and non-Malays(nma)

T-Test analysis was performed to identify gender and ethnicity differences in anthropometric dimensions. Male and female or Malay and Non-Malay were treated as two independent groups and the null-hypothesis tested the difference in the mean of each anthropometric dimensions between older women and older men or older Malay and older Non-Malay (H_0: $\mu_{1(m/rma)}-\mu_{2(f/nma)} = 0$).

Chi-square analysis was used to measure the level of relationship between gender and ethnicity in BMI categories. Use of chi-square deals with the situation in which we have two variables (gender and BMI categories or ethnicity and BMI categories) and to determine whether these variables are independent of one another (H_0: Independence between two variables).

2.2 Correlation between Age and Anthropometric dimension

To compare whether there is a significant correlation between age and the anthropometric dimensions of the Malaysian elderly, the null-hypothesis (H_0: $\rho = 0$) to test the significance of the relationship between the two variables was performed.

2.3 Relationship between Age and BMI Category

ANOVA test was used to identify the relationship between BMI categories and age. The null-hypothesis is (H_0: $\mu_1=\mu_2=\mu_3=\mu_4$) was tested.

2.4 Relationship between age, gender and ethnicity with BMI

As for correlation, regression is also used to study relationships between interval-ratio variables in which a single dependent (criterion) variable is regressed with one or several independent (predictor) variables.

3. Results and Discussions

3.1 Comparison between Male and Female Anthropometric Dimensions

The results of anthropometric dimensions (mean value, standard deviation and t-test) for males and females were presented in Table 1. Analysis showed that there were significant differences ($p<0.01$) in all anthropometric measurements between elderly men and women except for standing hip breadth. This finding was supported by a previous study by Haitao et al. (2007) where there is no significant difference between male and female elderly in the hip area dimension. For all measurements, the male dimensions exceeded the females except for hip breadth and standing chest depth.

3.2 Comparison between Malay and Non-Malay Anthropometric Dimensions

Analysis in Table 2 shows significant differences between Malay and Non-Malays in term of weight ($t=2.819$, $p<0.01$), kneecap height, standing($t=-4.021$, $p<0.01$), eye height, standing($t=-2.260$, $p<0.05$), elbow height, standing($t=-3.183$, $p<0.01$), sitting height($t=-3.254$,$p<0.01$), eye height, sitting($t=-3.049$, $p<0.01$), shoulder height, sitting($t=-2.652$, $p<0.01$), popliteal height, sitting($t=-2.185$, $p<0.05$), hip breadth, standing($t=2.703$, $p<0.01$), buttock-popliteal length, sitting($t=2.771$, $p<0.01$), shoulder-elbow length, sitting($t=-2.861$, $p<0.01$), span horizontal($t=-2.035$, $p<0.05$), thigh thickness, sitting($t=2.911$, $p<0.01$) and foot breadth($t=2.179$, $p<0.05$). Comparison between Chinese (Beijing) and Japanese elderly also showed that the anthropometric dimensions differences were found between this two groups (Haitao et al., 2007. It is observed that in almost all the measurements, the Non-Malays showed a higher reading compared to the Malays except for weight. The Malays are heavier and shorter. The significant differences in many of the measurements clearly indicate that ethnicity should be taken into consideration when designing within the Malaysian population.

3.3 Comparison between Male and Female Body Mass Index (BMI)

BMI differences were also found between gender in the four groups ($x^2=13.260$, df=3, $p=0.004$). About 50% of the male elderly were in the overweight and obesity group compared with the female elderly of 60%. The problem of obesity was more frequent in elderly women (26.7%) (Table 3). Based on Lenore (1996) in his study, women had a higher mean BMI and standard deviation than men. This clearly indicates that those belonging to these categories are at risks, with elderly females having higher risks. Probably as female aged, they become more sedentary. Thus, the lifestyles and nutrition of this group has to change.

3.4 Comparison between Malay and Non-Malay Body Mass Index (BMI)

Table 4 shows a significant relationship (x^2=16.580, df=3, p=0.001) between Malays and Non-Malays with the BMI category. Even though, this relationship seems very low (Cramer's V=.268), most Malay elderly have obesity and overweight problems than Non-Malays. Finding from a previous study also showed that there was a significant difference between ethnicity and BMI. The range of overweight among elderly women in Hong Kong was 2.5% compared to 53.5% in Barbados elderly women (Lenore, 1996). The reasons for the greater health risks posed by the Malays in this category, though maybe contributed by the unhealthy lifestyle including diet have to be studied further.

3.5 Correlation between Age and Anthropometric Dimensions

There were significant relationships between age and weight (r=-.171, p=0.009), kneecap height, standing (r=.210, p=0.001), chest depth, standing (r=-.153, p=0.02), hip breath, sitting (r=-.136, p=0.04), thigh thickness, sitting (r=-.146, p=0.027) and grip strength (r= -.151, p=0.022)(Table 3). An assumption can be made from this result is that the changes of body dimension are also related with increasing age. The negative correlation values showed that as age increases, these measurement decreases. A study by Bryna et al. (2001) on anthropometry changes among elderly Canadians found that body weight and stature declined with aging, particularly in the very old and those with dementia. Perissinotto et al. (2002) also showed that weight significantly decreased with age among elderly Italian population.

3.6 Relationship between Age and Body Mass Index (BMI)

Table 6 shows significant differences in age between the different BMI category (F=3.811, p=0.05). Most of young elderly have health problems in term of obesity and overweight (figure 1). These findings were similar to the results stated by Jeffrey (2005) where individuals aged 75 and older were the least likely to be overweight or obese as compared with other lower age groups.

3.7 Relationship between Age, Gender and Ethnicity with Body Mass Index

Three predictor variables accounted for 6.7% of variance in the Body Mass Index Category (F=10.918, df=3, p=.000). Regression shows (see Table 7) that age and ethnicity are significant predictors (p< .01) of BMI. Increasing age will reduce BMI values among the elderly. In ethnicity, overweight and obesity mostly tend to happen among Malay than Non-Malay. Otherwise, gender has no significant influence on Body Mass Index among older persons.

4. Conclusion

This study has shown that the anthropometric dimensions and Body Mass Index (BMI) is closely linked with some demographic background. Age and ethnicity remains the best predictor for elderly BMI in Malaysia. Considerations on these factors are very important when designing products, facilities or tools to meet the needs and wants elderly population. Therefore, by providing this empirical data it can be useful for dietitians, clinicians and other groups whose work are related to ageing and elderly. The study reinforces the findings of some other studies that showed elderly women are more at health risks due to overweight and obesity compared to elderly men. The study also clearly identified that the Malays were at higher health risks as compared to the non-Malays. This call for a change of lifestyles and diet as these are the two most common causes of overweight and obesity among populations.

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Table 1. Mean, standard deviation and t-test for anthropometric dimensions of older Malaysians males and females aged 60 and above (n=230)

	Male, N=129		Female, N=101		Independent t-test	
Dimensions (cm)	**Mean**	**Std.Dev**	**Mean**	**Std. Dev**	**t**	**p**
1.Weight (Kg)	66.6	11.3	60.0	13.8	4.002	0.000
2.Height	162.3	7.5	149.0	5.8	14.724	0.000
3.Coat Height, Standing	139.2	6.0	127.3	5.4	15.695	0.000
4.Shoulder Height, Standing	134.7	5.8	122.0	5.3	17.221	0.000
5. Waist Height, Standing	94.1	5.6	88.4	4.5	8.310	0.000
6.Crotch Height, Standing	71.0	4.0	65.9	4.3	9.399	0.000
7.Kneecap Height, Standing	50.0	3.3	44.3	2.9	13.579	0.000
8.Eye Height, Standing	149.9	6.1	136.4	5.8	17.100	0.000
9.Elbow Height, Standing	97.1	5.8	89.2	4.4	11.333	0.000
10.Sitting Height	83.1	4.3	76.4	3.8	12.335	0.000
11.Eye Height, Sitting	71.6	5.6	65.0	3.8	10.266	0.000
12.Shoulder Height, Sitting	56.7	3.5	50.6	5.7	9.993	0.000
13.Knee Height, Sitting	49.8	2.9	45.1	2.1	13.682	0.000
14.Popliteal Height, Sitting	39.6	2.4	36.5	1.7	10.961	0.000
15.Arm Reach Upward, Sitting	126.6	5.7	108.4	10.7	16.636	0.000
16.Hip Breadth, Standing	31.5	2.4	32.0	3.1	-1.313	0.191
17.Chest (Bust) Depth, Standing	23.1	2.6	25.9	3.6	-6.607	0.000
18.Shoulder Breadth, Sitting	41.9	3.4	37.0	3.0	11.491	0.000
19.Hip Breath, Sitting	35.0	3.5	33.3	4.0	3.506	0.001
20.Forearm-Hand Length (Elbow-Finger Tip Length), Sitting	45.5	2.0	42.2	2.6	10.595	0.000
21.Buttock-Knee Length, Sitting	53.7	3.6	52.4	2.8	2.872	0.004
22.Buttock-Popliteal Length, Sitting	45.5	2.7	42.4	2.8	8.476	0.000
23.Shoulder-Elbow Length, Sitting	35.7	1.9	32.9	1.8	11.182	0.000
24.Arm Reach Forward, Sitting	76.2	5.6	69.7	5.2	9.060	0.000
25.Shoulder Grip Length, Sitting	63.5	4.2	57.8	4.5	9.837	0.000
26.Upper Limb Length	72.3	3.7	66.6	3.7	11.641	0.000
27.Span Horizontal	169.1	7.9	156.4	7.3	12.515	0.000
28.Elbow Span	90.8	4.1	82.0	5.2	13.881	0.000
29.Thigh Thickness, Sitting	14.6	2.2	12.8	2.3	6.046	0.000
30.Hand Length	17.8	1.2	16.4	1.1	9.286	0.000
31.Palm Length	10.3	1.0	9.4	1.1	6.731	0.000
32.Hand Breadth	8.6	0.5	7.7	0.4	15.064	0.000
33.Foot Length	24.6	1.1	22.4	2.0	10.695	0.000
34.Instep Length	18.4	1.3	16.4	1.1	12.536	0.000
35.Foot Breadth	10.2	0.7	9.0	0.6	13.715	0.000
36.Heel Breadth	6.5	0.7	6.1	0.6	4.764	0.000
37.Thumb Strength (Kg/N)	7.9	1.7	4.5	1.4	16.759	0.000
38.Grip Strength (Kg/N)	31.5	7.7	17.5	5.9	15.487	0.000
39.Arm Reach Upward, Standing	247.4	9.9	227.8	8.2	15.990	0.000

** significant at the 0.01 level (2 –tailed)

* significant at the 0.05 level (2 –tailed)

Table 2. T-test for anthropometric dimensions and ethnicity among older Malaysians (male and female) aged 60 years and above

Dimensions (cm)	Malay, N=174		Non-Malay, N=56		Independent t-test	
	Mean	Std. Dev	Mean	Std. Dev	t	p
1.Weight (Kg)	64.998	13.074	59.511	11.302	2.819	.005**
2. Height	155.782	9.550	158.600	8.881	-1.953	.052
3. Coat Height, Standing	133.365	7.959	135.884	8.840	-1.899	.061
4. Shoulder Height, Standing	128.529	8.324	131.018	8.563	-1.933	.055
5. Waist Height, Standing	91.534	6.095	91.833	5.232	-.329	.742
6. Crotch Height, Standing	68.582	4.650	69.330	5.367	-1.006	.316
7. Kneecap Height, Standing	46.891	4.097	49.416	4.058	-4.021	.000**
8. Eye Height, Standing	143.224	8.997	146.311	8.549	-2.260	.025*
9. Elbow Height, Standing	92.895	6.586	96.023	5.759	-3.183	.002**
10. Sitting Height	79.509	5.187	82.082	5.027	-3.254	.001**
11. Eye Height, Sitting	68.054	5.405	70.766	6.857	-2.260	.025*
12. Shoulder Height, Sitting	53.553	5.614	55.618	4.881	-3.183	.002**
13. Knee Height, Sitting	47.483	3.324	48.425	3.978	-3.254	.001**
14. Popliteal Height, Sitting	38.056	2.489	38.921	2.839	-3.049	.003**
15. Arm Reach Upward, Sitting	118.053	12.691	120.420	10.549	-2.652	.009*
16. Hip Breadth, Standing	32.011	2.750	30.895	2.475	-1.756	.080
17. Chest (Bust) Depth, Standing	24.530	3.557	23.664	2.801	-2.185	.030*
18. Shoulder Breadth, Sitting	40.034	4.085	38.909	3.767	-1.261	.208
19. Hip Breath, Sitting	34.545	3.493	33.473	4.579	2.703	.007**
20. Forearm-Hand Length (Elbow-Finger Tip Length), Sitting	44.104	2.682	43.963	3.099	1.661	.098
21. Buttock-Knee Length, Sitting	53.298	3.321	52.584	3.367	1.903	.060
22. Buttock-Popliteal Length, Sitting	44.491	2.952	43.166	3.568	1.844	.067
23. Shoulder-Elbow Length, Sitting	34.241	2.328	35.236	2.055	.332	.740
24. Arm Reach Forward, Sitting	73.494	6.258	73.033	6.448	1.396	.164
25. Shoulder Grip Length, Sitting	61.068	5.154	60.718	5.125	2.771	.006**
26. Upper Limb Length	69.717	4.494	69.986	5.263	-2.861	.005**
27. Span Horizontal	162.747	9.440	165.816	10.922	.475	.635
28. Elbow Span	86.640	6.627	87.916	5.253	.444	.658
29. Thigh Thickness, Sitting	14.086	2.455	13.021	2.124	-.373	.709
30. Hand Length	17.172	1.253	17.156	1.561	-2.035	.043*
31. Palm Length	9.916	1.230	9.952	.8983	-1.314	.190
32. Hand Breadth	8.204	.630	8.084	.561	1.269	.206
33. Foot Length	23.644	1.903	23.695	1.907	-.175	.861
34. Instep Length	17.506	1.582	17.670	1.566	-.677	.501
35. Foot Breadth	9.717	.899	9.414	.917	2.179	.030*
36. Heel Breadth	6.341	.670	6.247	.679	.911	.363
37. Thumb Strength (Kg/N)	6.266	2.213	6.777	2.663	-1.426	.155
38. Grip Strength (Kg/N)	25.298	9.484	25.446	11.000	-.098	.922
39. Arm Reach Upward, Standing	237.940	13.230	241.480	13.768	-1.690	.094

** significant at the 0.01 level (2 –tailed)

* significant at the 0.05 level (2 –tailed)

Table 3. Relationship between Body Mass Index (BMI) category and gender (n=230)

Gender	**BMI Category**				**Total**
	Underweight (Below 18.5)	**Normal (18.5-24.9)**	**Overweight (25.0-29.9)**	**Obesity (30.0 and over)**	
Male	5	60	51	13	129
	3.9%	46.5%	39.5%	10.1%	100.0%
Female	7	33	34	27	101
	6.9%	32.7%	33.7%	26.7%	100.0%
Total	12	93	85	40	230
	5.2%	40.4%	37.0%	17.4%	100.0%

x^2=13.260, df=3, p=0.004

Table 4. Chi-square analysis of BMI Category between Malay and Non-Malay (n=230)

Ethnicity groups	**BMI Category**				**Total**
	Underweight (Below 18.5)	**Normal (18.5-24.9)**	**Overweight (25.0-29.9)**	**Obesity (30.0 and over)**	
Malay	7	62	66	39	174
	4.0%	35.7%	37.9%	22.4%	100.0%
Non-Malay	5	31	19	1	56
	8.9%	55.4%	33.9%	1.8%	100.0%
Total	12	93	85	40	230
	5.2%	40.4%	36.9%	17.5%	100.0%

x^2=16.580, df=3, p=0.001 Cramer's V =. 268

Table 5. Correlations-test for anthropometric measurements of older Malaysians males and females and age (n=230)

Anthropometric Dimensions	r	p
1. Weight (Kg)	-.171**	.009
2. Height	.025	.708
3. Coat Height, Standing	.023	.725
4. Shoulder Height, Standing	.020	.759
5. Waist Height, Standing	.064	.331
6. Crotch Height, Standing	.021	.746
7. Kneecap Height, Standing	.210**	.001
8. Eye Height, Standing	.035	.597
9. Elbow Height, Standing	.024	.716
10. Sitting Height	.018	.787
11. Eye Height, Sitting	.014	.828
12. Shoulder Height, Sitting	.036	.584
13. Knee Height, Sitting	.063	.338
14. Popliteal Height, Sitting	.037	.572
15. Arm Reach Upward, Sitting	.049	.462
16. Hip Breadth, Standing	-.118	.075
17. Chest (Bust) Depth, Standing	-.153*	.020
18. Shoulder Breadth, Sitting	-.090	.173
19. Hip Breath, Sitting	-.136*	.040
20. Forearm-Hand Length (Elbow-Finger Tip Length), Sitting	.053	.423
21. Buttock-Knee Length, Sitting	-.066	.319
22. Buttock-Popliteal Length, Sitting	.006	.926
23. Shoulder-Elbow Length, Sitting	.063	.340
24. Arm Reach Forward, Sitting	.008	.906
25. Shoulder Grip Length, Sitting	-.032	.630
26. Upper Limb Length	.036	.583

27. Span Horizontal	-.018	.787
28. Elbow Span	.037	.578
29. Thigh Thickness, Sitting	-.146*	.027
30. Hand Length	.031	.641
31. Palm Length	.066	.320
32. Hand Breadth	.080	.227
33. Foot Length	.072	.277
34. Instep Length	.124	.060
35. Foot Breadth	.058	.380
36. Heel Breadth	.007	.917
37. Thumb Strength (Kg/N)	-.035	.599
38. Grip Strength (Kg/N)	-.151*	.022
39. Arm Reach Upward, Standing	.036	.590

** Correlation is significant at the 0.01 level (2 –tailed)

* Correlation is significant at the 0.05 level (2 –tailed)

Table 6. One-Way Analysis of Variance (ANOVA) for Body Mass Index (BMI) category and age among older Malaysians (male and female) aged 60 years and above

Source	df	SS	MS	F
Between Groups	**3**	**299.383**	**99.794**	**3.811***
Within Groups	226	5918.465	26.188	
Total	229	6217848		

* $p < .05$

Table 7. Summary of Regression Analysis for Variables Predicting Elderly Body Mass Index (n=230)

Variable	***B***	***SE B***	**ß**	**p**
F=10.918, df=3, p=.000				
(Constant)	4.471	.672		.000
Age	**-.031**	**.010**	**-.195****	**.002**
Gender	-.192	.104	-.116	.066
Ethnicity	**.491**	**.119**	**.256****	**.000**

Note: $R^2 = .127$

** p< .01

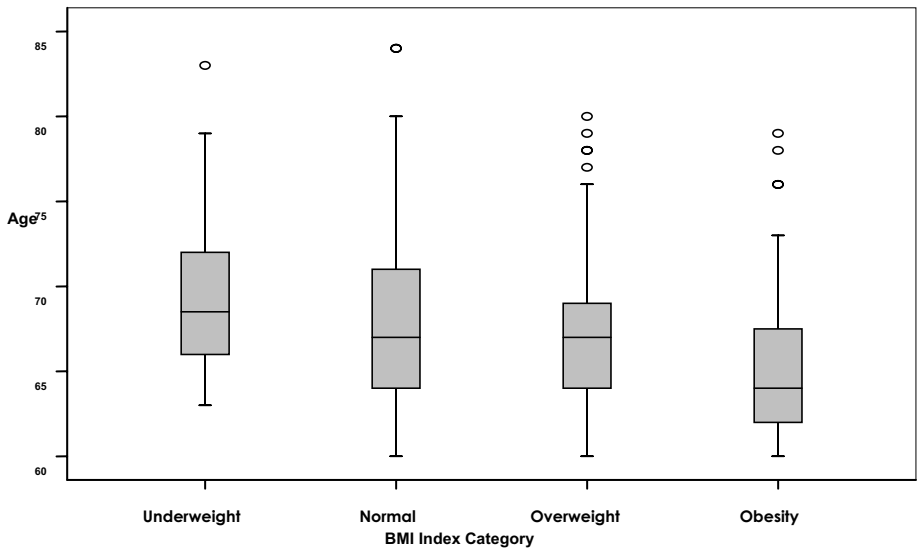

Figure 1. Box-and-Whisker Plot for Body Mass Index (BMI) category and age among older Malaysians (male and female) aged 60 years and above