Original Article

Prevalence of overweight among Malaysian adults from rural communities

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Assessment of the nutritional status of 4054 households from rural communities in Peninsular Malaysia was undertaken from 1992 to 1995. Body mass index (BMI) and waist-to-hip ratio (WHR) were obtained from a self-selected sample of 1854 men and 2741 women aged ≥ 18 years. The BMI and WHR results are presented according to gender, age groups and type of community as defined by the main occupation, namely, fishing, rice farming, estate work, rubber and coconut small-holding. The mean BMI for men and women of all age groups are 22.5 kg/m^2 and 23.8 kg/m^2, respectively. The mean BMI for both genders increases with age between 18.0 and 49.9 years, after which the value declines. The prevalence of pre-obese (BMI ≥ 25.0–29.9 kg/m^2) is 19.8% for men and 28.0% for women. The prevalence of obese men and women (≥ 30.0 kg/m^2) is 4.2% and 11.1%, respectively. The highest prevalence of pre-obese and obese men is found in the age groups of 30.0–49.9 years, while that for women is in the 40.0–49.9 years age group. The prevalence of pre-obesity and obesity is higher in women than in men for every age group. A similar result was indicated by WHR whereby a higher proportion of women (22.5%) than men (5%) for all ages was found to show central obesity. The prevalence of overweight adults is higher when compared with previous studies on subjects from almost similar rural communities. This study indicated that overweight is on the increase in rural communities, especially among female subjects.

Key words: nutritional status, body mass index, waist-to-hip ratio, obesity, rural communities, Malaysia.

Introduction

Lifestyle factors including dietary habits, tobacco and alcohol use, occupational exposures, sedentary lifestyle and psychosocial stress are known to lead to an increased biological risk for chronic disease. As populations grow older and the ratio of deaths due to chronic diseases versus infectious diseases increases, it is important from health policy implications to determine the extent to which adults are experiencing increases in biological risks for chronic disease.[1]

A key biological risk factor for chronic diseases is obesity. The problem of obesity has drawn much concern as it has reached epidemic proportions, affecting adults and children in both developed and developing countries.[2] In the USA, 54% of adults are overweight (body mass index (BMI) ≥ 25.0–29.9 kg/m^2) and 22% are obese (BMI ≥ 30 kg/m^2).[3]

Based on similar BMI cut-off points, the Second National Health and Morbidity Survey of Malaysia reported the prevalence of obesity and overweight as 4.4% and 16.6%, respectively, in a survey undertaken between 1994 and 1996 involving more than 30 000 subjects aged 18 years and older.[4] Overweight was higher in urban (17.4%) than in rural populations (15.5%). In a study on 1827 urban Malay adults, prevalence of overweight at 23.9% and 19.6% in men and women, respectively, was reported.[5] Reports by Arshad *et al.* and Teo *et al.* on overweight in urban Malay adults, albeit involving a smaller number of subjects, reported an overweight prevalence of 36.8% in men and 38.8% in women, for the former, while the latter found an overweight level of 41.4% in men.[6,7]

In contrast, a relatively lower prevalence of overweight had been reported in rural populations. Overweight was found in 5% of 522 men and 15% of 965 women from poor villages.[8] In a study on 107 men and women in Ulu Terengganu, less than 3% had BMI exceeding 24.0 kg/m^2.[9]

In fact, previous studies have shown a preponderance of underweight among Malay adults from rural areas. In a study on very poor villages, 45% of the men had BMI < 20 kg/m^2 while 31% of the women had BMI < 19 kg/m^2.[8] Low prevalence of underweight (BMI = 18.5 kg/m^2) from rural areas was also reported in men (10.8%) and women (14%).[5]

Both overweight and underweight in adults are associated with increased all-cause mortality in a U- or J-shaped curve. High mortality at the underweight end is dominated by digestive and pulmonary disease, while at the overweight end it is related to chronic diseases including corony heart disease

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(CHD), diabetes mellitus and gall bladder disease.[10] Chronic energy deficiency (CED) is a matter of public health concern with economic implications including the association between CED in pregnancy and low birthweight, and between CED and low work productivity.[11]

This report presents the anthropometric status of adults from a study on the nutritional status of households in rural villages and estates. The anthropometric status is presented as BMI and waist-to-hip ratio (WHR). While BMI is an index of overall bodyweight-for-stature, WHR serves as an indicator of abdominal fat accumulation which, in turn, has been shown to reflect changes in risk factors for CHD and other forms of chronic disease.[12]

Methods

Study communities

The study on the nutritional status of households in rural villages and estates was carried out from 1992 to 1995 in Peninsular Malaysia. Five types of communities were studied, ely, fishing, rice farming, rubber smallholding, coconut smallholding and estates in the peninsula. The study villages and estates were selected from census data provided by the Ministry of Agriculture (1990 Farmers' Census), Fisheries Development Authority (1991 Census of Fishermen Associations) and the National Union of Plantation Workers. The villages and estates were selected in such a manner that they were representative of the five types of communities mentioned. Details pertaining to the sampling process as well as the socioeconomic profile of study households were previously described.[13]

A total of 69 villages and seven estates located in nine states in Peninsular Malaysia were selected for the study. In each study village or estate, all of the households were interviewed using a structured and coded questionnaire. All household members were asked to be present at a community-based centre, where a team comprising nutritionists, a medical doctor and laboratory assistants took anthropometric measurements and carried out blood analysis and clinical nination of the subjects.

This report focuses on the results from BMI and WHR measurements of adult male and female subjects.

Anthropometric measurements

Details pertaining to the measurements of body weight and height have been previously elaborated.[14] Body weight was taken using a TANITA (Tanita Corp., Tokyo, Japan) or SECA (Vogel & Halke Gmbh, Hamburg, Germany) electronic digital balance to the nearest 0.1 kg. Subjects were weighed barefooted and with light clothing on. Height was recorded using a microtorise tape (Stanley-Mabo Besancon, London, UK) to the nearest 0.1 cm. The tape was suspended two metres from the floor against a straight wall or pillar.

A non-stretchable tape was used to measure waist and hip circumferences to the nearest 0.1 mm. Waist circumference was taken at the minimum circumference between the iliac crest and the rib cage, while hip circumference was measured at the maximum width over the greater trochanters. Subjects were requested to raise their blouse or shirt for measurement of waist circumference. Contents of the inside back pockets of trousers such as wallet and comb were removed before the hip circumference was taken. A standing screen was used to provide privacy for subjects when measurements were taken.

Classification of overweight and obesity in adults according to body mass index

The classification of overweight and obesity in adults according to BMI is shown in Table 1.[2]

Cut-off point of waist-to-hip ratio

The cut-off point of waist-to-hip ratio for men was greater than 1.0 and for women it was greater than 0.85.[2]

Results

Household size and income

Mean household size and income according to the five types of communities is shown in Table 2. As previously reported,[13] the overall mean household size was 5.3 with the fishing community having the highest mean household size at 5.9 members. The mean monthly household income for all groups was RM574, which is lower than the mean monthly gross household income for Malaysia as a whole (RM1563 in 1993). This is expected as the study communities are in the agricultural sector, which has a significant proportion of poor households. In this study, the prevalence of poverty was found to be highest in the rice farming community (61%), followed by the rubber smallholdings (50%) and fishing community. Poverty line income in Malaysia, at the time of this study, was defined as RM405 for a household size of 4.8.

Distribution of subjects by gender and age

A total of 4595 subjects aged 18 years and above comprising 1854 men and 2741 women were measured for bodyweight, height, waist and hip circumferences. More women than men came to the centre to be measured, probably because many of the women were full-time housewives and could find time to go to the centre, whereas many of the men work away from home. Another reason for higher attendance by the women was that they brought their young children to be examined by the attending doctor in the centre, who also provided treatment for minor illnesses free of charge. Although the centre was set up until late in the evening on certain days to cater for subjects who were away during the daytime, not many men came to the centre in the evening.

Among the male subjects, 29.1% were aged 18.0–39.9 years while 45.4% were aged 40.0–59.9 years; the remaining 25.5% can be classified as elderly (≥ 60 years) (Table 3). As for the female subjects, 41.3% were between 18.0 and 39.9

Table 1. Classification of overweight and obesity in adults according to body mass index

Classification	BMI (kg/m^2)	Risk of morbidities
Underweight (CED)	< 18.5	Low*
Normal range	18.5–24.9	Average
Overweight		
Pre-obese	25–29.9	Increased
Obese class I	30.0–34.9	Moderate
Obese class II	35.0–39.9	Severe
Obese class III	≥ 40.0	Very severe

BMI, body mass index; CED, chronic energy deficiency. *However, risk of other clinical problems increased.

Table 2. Mean household size and income*

	n	Mean household size	Median household size	Mean monthly household income (RM)**	Median household income (RM)	Mean monthly per capita household income (RM)	Median monthly per capita household income (RM)
Padi	1001	5.3	5	486	333	101	71
Rubber	883	4.8	4	466	370	110	84
Coconut	568	4.7	4	625	431	150	106
Estate	322	5.6	5	829	700	162	140
Fishing	1280	5.9	6	630	500	118	90
All	4054	5.3	5	574	450	120	90

*Data were taken from Chee *et al.*[13] **RM, Malaysian Ringgit (US$1 = RM3.80).

Table 3. Distribution of subjects by age

Age (years)	Men		Women	
	n	%	*n*	%
18.0–29.9	262	14.1	471	17.2
30.0–39.9	278	15.0	660	24.1
40.0–49.9	406	21.9	646	23.6
50.0–59.9	436	23.5	498	18.2
≥ 60.0	472	25.5	466	17.0
Total	1854	100.0	2741	100.0

years of age followed by an almost equal proportion (41.8%) who were aged 40.0–59.9 years while 17.0% were elderly.

Mean weight and height of subjects

The mean weight of men and women in the 18.0–29.9 years age category is 58.3 kg and 51.3 kg, respectively (Table 4). The mean weight for both genders is highest for the age groups of 30.0–49.9 years, while it is lowest at ≥ 60 years. After age 60, mean body weight is 54.2 kg for male elderly and 48.3 kg for the females.

The average height for men between 18.0 and 49.9 years age is approximately 162 cm while that for the women in a similar age group is approximately 151 cm. The mean height is lower in the older age groups, and among the elderly it is 159 cm and 146 cm for men and women, respectively.

The mean weight and height of the subjects in the present study are compared with previous findings on Malays from almost similar socioeconomic backgrounds based on agricultural activities and characterized by low household income. It can be seen from past and present studies that the body weight of rural Malay men averages < 60 kg compared with 63.7 kg for urban Malay men (Table 5). The increase in mean body weight over the years for men is small whereas the increase for women is higher. The mean weight for women reported in 1984[8] was 46.3 kg compared with 53.8 kg in the present report, which is close to the mean value of 55.9 kg for urban women.[15]

The average height for urban men and women appears to be higher than the mean values for rural men and women. The mean height of urban men and women were reported as 165.4 cm and 154.0 cm, respectively, whereas the corresponding figures for the present study are 161.4 cm and 149.7 cm.[15] However, it is noted that the proportion of elderly subjects reported for the urban subjects is less than 5% compared with 26.1% and 17.5% for elderly men and women, respectively, in the present study.[15] As is commonly known, in general the mean height of the elderly is lower than that of younger age groups for both men and women. Hence, a larger proportion of the elderly in the present study sample would lead to a lower mean height value.

Table 4. Mean weight and height by gender and age of subjects

Age (years)	*n*	Weight (kg) (mean ± SD)	Height (cm) (mean ± SD)
Men			
18.0–29.9	262	58.3 ± 11.4	164.2 ± 6.8
30.0–39.9	278	62.5 ± 11.4	162.8 ± 6.1
40.0–49.9	406	62.1 ± 11.2	162.1 ± 6.0
50.0–59.9	436	58.8 ± 10.9	160.5 ± 5.9
≥ 60.0	472	54.2 ± 10.2	159.0 ± 6.2
Women			
18.0–29.9	471	51.3 ± 10.6	151.5 ± 5.8
30.0–39.9	660	56.7 ± 11.3	151.6 ± 5.4
40.0–49.9	646	57.0 ± 11.6	150.4 ± 5.6
50.0–59.9	498	53.3 ± 11.5	148.3 ± 5.8
≥ 60.0	466	48.3 ± 11.4	146.3 ± 5.9

Table 5. Comparison of mean bodyweight and height of Malay adults

	Men			Women		
n	Weight (kg)	Height (cm)	*n*	Weight (kg)	Height (cm)	Study period (Reference)
106	5.4	162.1	134	43.3	147.9	1947–49 (27[a])
522	52.4	159.8	965	46.3	148.7	1979–83 (8[b])
1873	59.1	161.4	2757	53.8	149.7	1992–94 (Present study[c])
677	63.7	165.4	570	55.9	154.0	1984–89 (15[d])

[a]Peasants and fishermen; [b]rice farmers, rubber small-holders and fishermen; [c]rice farmers, rubber and coconut small-holders, fishermen and estate workers; [d]urban office workers and university students.

Mean body mass index

Body mass index of men by age. The mean BMI of men increases from 21.6 kg/m^2 in the 18.0–29.9 years age group to 23.6 kg/m^2 for the 30.0–39.9 years and 40.0–49.9 years age groups (Table 6). After that, the mean BMI value decreases to 22.8 kg/m^2 for ages 50.0–59.9 years and declines further to 21.4 kg/m^2 in the elderly group.

Overall, almost two-thirds of the men have normal BMI values, while 12.7% can be classified as chronic energy deficient (CED) (BMI < 18.5 kg/m^2). The percentage of CED is

Table 6. Body mass index of men according to age groups

Age (years)	*n*	Body mass index (kg/m²)				
		Mean (± SD) (kg/m²)	< 18.5 (%)	18.5–24.9 (%)	25.0–29.9 (%)	≥ 30.0 (%)
18.0–29.9	262	21.6 ± 3.8	15.6	68.7	12.2	3.4
30.0–39.9	278	23.6 ± 3.9	6.5	62.2	23.4	7.9
40.0–49.9	406	23.6 ± 3.8	4.9	64.0	26.1	4.9
50.0–59.9	436	22.8 ± 3.9	11.9	61.7	21.8	4.6
≥ 60.0	472	21.4 ± 3.6	22.2	60.6	15.0	2.1
All ages (≥ 18.0)	1854	22.5 ± 3.9	13.2	62.8	19.8	4.2

highest among the elderly (22.2%), followed by the 18.0–29.9 years age group (15.6%). The lowest percentage of CED in men is in the 40.0–49.9 years age group (4.9%).

In fact, the 40.0–49.9 years age group showed the highest proportion (26.1%) of pre-obese men (BMI ≥ 25.0–29.9 kg/m²) followed by the age groups of 30.0–39.9 years (23.4%) and 50.0–59.9 years (21.8%). The prevalence of bese men (BMI ≥ 30 kg/m²) is highest in the 30.0–39.9 years age group (7.9%), followed by the 40.0–49.9 years age group (4.7%). Thus, the highest prevalences of pre-obese and obese men are in the thirties and forties age groups

Body mass index of women by age. The mean BMI of women is shown lowest at 22.3 kg/m² for the 18.0–29.9 years age group and highest at 25.1 kg/m² for the 40.0–49.9 years age group (Table 7). Less than half (48.5%) of the women for all ages have normal BMI values. The overall proportion of CED is almost similar to that for men (12.4%), and as in the case for men, elderly women have the highest proportion of CED (25.7%). Thus, approximately one in four of the elderly men and a similar proportion of the elderly women from poor rural households are underweight.

In contrast, the overall prevalence of pre-obese and obese women are 28.0% and 11.1%, respectively. Specifically, the age group of 40.0–49.9 years has the highest proportion of pre-obese and obese women. One-third (33.5%) in this group are pre-obese while another 16.5% are obese. The next highest prevalence of pre-obese and obese women is in the 50.0–59.9 years age group at 31.1% and 10.6%, respectively.

A comparison of mean BMI values of Malay adults from this study with those from rural and urban areas in Malaysia is presented in Table 8. It appears that in the rural communities, the mean BMI of both men and women are higher in the 1990s compared with findings of similar types of communities in the 1970–80s. The average BMI of men and women from poor villages were 20.4 and 20.9 kg/m², respectively, compared with the corresponding figures of 22.5 and 23.7 kg/m² in the present study.[8] It is noteworthy that the present report of the mean BMI for rural women at 23.7 kg/m² is higher than the mean BMI reported for urban Malay women at 22.9 kg/m².[5] The BMI for men from rural communities remain lower than those for their urban counterparts. The mean BMI of men in the present study is 22.5 kg/m² compared with 23.3 kg/m² for urban men.[5,7]

Mean waist and hip circumference

The mean waist and hip circumferences are presented according to age and gender in Table 9. Waist circumference increases with age for both men and women until about the age of 50 years, after which it declines. The highest mean waist circumference is recorded for the 40.0–40.9 age group, namely, 82.2 cm for men and 76.2 cm for women. A similar pattern prevails for hip circumference in that it increases with age and decreases after about 50 years of age.

Waist-to-hip ratio

Waist-to-hip ratio by gender and age. The results of the measurements of waist and hip circumferences of men and women are presented as WHR in Table 10. The mean WHR for men increases from 0.84 for ages 18.0–29.9 years to 0.90 for ages in the forties and fifties. The proportion of men having WHR ≥ 1.0, which is indicative of central obesity, is seen to increase with age, from 1.9% in the youngest age group of 18.0–29.9 years to the highest prevalence of 8.0% in the 50.0–59.9 years age group. Nonetheless, the overall mean WHR for men is 0.89 and a relatively small percentage (5.0%) exceed the cut-off point for central obesity.

As for women, their mean WHR increases from 0.76 in the 18.0–29.9 age group to 0.83 among the elderly. Compared with men, a higher prevalence of women showed central obesity. Overall, 22.5% of the women exceeded the WHR cut-off point of 0.85. The prevalence of women with WHR > 0.85 increases substantially with age from 7.1% in the 18.0–29.9 years group to 39.5% among the elderly.

Table 7. Body mass index of women according to age groups

Age (years)	*n*	Body mass index (kg/m²)				
		Mean (± SD) (kg/m²)	< 18.5 (%)	18.5–24.9 (%)	25.0–29.9 (%)	≥ 30.0 (%)
18.0–29.9	471	22.3 ± 4.1	17.4	58.6	19.7	4.2
30.0–39.9	660	24.7 ± 4.7	7.3	49.5	30.2	13.0
40.0–49.9	646	25.1 ± 4.9	7.1	42.3	33.7	16.9
50.0–59.9	498	24.2 ± 4.8	11.2	46.8	31.3	10.6
≥ 60.0	466	22.6 ± 5.2	23.4	47.2	21.7	7.7
All ages (≥ 18.0)	2751	23.8 ± 4.9	12.4	48.5	28.0	11.1

Table 8. Comparison of body mass index of rural Malay adults

Men kg/m² (*n*)	Women kg/m² (*n*)	Study period (Reference)
20.3 (154)	19.8 (134)	1947–49 (27[a])
20.4 (522)	20.9 (965)	1979–83 (8[b])
23.3 (677)	22.9 (570)	1984–89 (15[d])
22.5 (1854)	23.8 (2751)	1992–94 (Present study[c])

[a]Peasants and fishermen; [b]rice farmers, rubber small-holders and fishermen; [c]rice farmers, rubber and coconut small-holders, fishermen and estate workers; [d]urban office workers and university students.

Table 9. Mean waist circumference and hip circumference by gender and age of subjects

Age (years)	*n*	Waist circumference (cm) (mean ± SD)	Hip circumference (cm) (mean ± SD)
Men			
18.0–29.9	258	74.1 ± 10.4	88.4 ± 8.2
30.0–39.9	277	80.7 ± 10.7	90.9 ± 7.9
40.0–49.9	413	82.2 ± 10.6	90.9 ± 8.5
50.0–59.9	436	80.9 ± 11.7	89.6 ± 8.6
≥ 60.0	476	77.4 ± 10.2	87.4 ±7.6
Women			
18.0–29.9	425	68.6 ± 8.8	89.7 ± 8.3
30.0–39.9	620	75.1 ± 10.5	94.0 ± 10.0
40.0–49.9	634	76.2 ± 11.5	94.7 ± 10.7
50.0–59.9	493	75.8 ± 10.7	92.4 ± 10.5
≥ 60.0	468	73.9 ± 11.7	88.9 ± 11.4

Correlation between body mass index and waist-to-hip ratio by age and gender

Body mass index correlates significantly and positively with waist-to-hip ratio for all ages in both men and women (Table 11). Overall, the correlation coefficient for men is $r = 0.507$ while that for women is $r = 0.359$. Among the men, the correlation was highest in the 30.0–39.9 years age group ($r = 0.613$). As for women, BMI and WHR relate with each other at a moderate correlation level and within a narrow range of the coefficient value (between $r = 0.328$–0.395) for all age groups.

Body mass index and waist-to-hip ratio by type of community

Table 12 shows the mean BMI values of men and women in the five types of communities studied. In general, men and women in all types of communities have a lower BMI in the younger age groups (18.0–39.9 years) than those above 40 years of age. The mean BMI value for men ranges from 21.4 to 23.4 kg/m² while it ranges from 22.3 to 26.0 kg/m² in women. Differences in mean BMI values between the age groups of 18.0–39.9 years and 40.0–59.9 years are significant for men in the fishing and rubber communities and for women in the fishing and coconut communities. It is noted that women in the fishing community showed the highest BMI for each age group among the five types of communities. In the fishing and coconut categories, it is usually the men who carry out the physical work involved, compared with rice farming and rubber tapping where both men and women can be actively involved.

It is also noted that in every type of community, the elderly have the lowest mean BMI values. The mean BMI for male elderly ranges from 20.3 kg/m² in the estates to 22.1 kg/m² in the coconut smallholding community. The mean BMI for female elderly shows a wider range, varying from 20.9 kg/m² in the rice farming community to 24.5 kg/m² in the fishing community. The difference in the mean BMI values between the elderly (≥ 60 years) and those between 18.0 and 59.9 years is significant for both men and women.

The mean WHR for men and women by age category in each type of community is shown in Table 13. In every type of community, the mean WHR of men and women is lowest for the youngest age group of 18.0–39.9 years. As described above, WHR increases with age, reaching its peak in the 40.0–59.9 years age category before declining somewhat in the ≥ 60 years age category for men, but not so for elderly women. The mean WHR for each age group is highest in the fishing community and for women in the estate community. The mean WHR for the elderly is highest in the coconut and estate communities.

Discussion

It appears that the mean bodyweight of Malay men and women from rural areas has increased over the decades, probably due to an improvement in overall socioeconomic status. The mean BMI of these subjects is also higher compared with studies of similar communities undertaken in the 1970s–80s.[8] This finding is in tandem with the recent report of an increase in the mean BMI in all major regions of the developing world.[1]

The prevalence of underweight or CED subjects (12.7% of the men and 12.4% for women of all ages) is of almost similar magnitude as that reported for men of low socioeconomic status from South and South-east Asia (15.1%).[1]

There are few studies on the extent to which low BMI impairs physical functions and morbidity in developing countries. A study on Iban adults in Sarawak found morbidity to be significantly related to BMI in men but not in women.[16] It was suggested that female lean tissue is more

Table 10. Classification of waist-to-hip ratio by gender and age

Age (years)	Men				Women			
	n	Mean (±SD)	≤ 1.0 *n* (%)	> 1.0 *n* (%)	*n*	Mean (± SD)	≤ 0.85 *n* (%)	> 0.85 *n* (%)
18.0–29.9	257	0.84 ± 0.07	252 (98.1)	5 (1.9)	424	0.76 ± 0.06	394 (92.9)	30 (7.1)
30.0–39.9	277	0.89 ± 0.07	269 (97.1)	8 (2.9)	620	0.80 ± 0.07	514 (82.9)	106 (17.1)
40.0–49.9	412	0.90 ± 0.09	393 (95.4)	19 (4.6)	632	0.80 ± 0.06	505 (79.9)	127 (20.1)
50.0–59.9	436	0.90 ± 0.07	401 (92.0)	35 (8.0)	493	0.82 ± 0.06	347 (70.4)	146 (29.6)
≥ 60.0	474	0.88 ± 0.08	448 (94.5)	26 (5.5)	468	0.83 ± 0.08	283 (60.5)	185 (39.5)
All ages (≥ 18.0)	1856	0.89 ± 0.08	1763 (95.0)	93 (5.0)	2637	0.80 ± 0.07	2043 (77.5)	594 (22.5)

Table 11. Pearson correlation coefficients between body mass index (BMI) and waist-to-hip ratio (WHR) by age and gender

Age (years)	Men		Women	
	n	*r*	*n*	*r*
18.0–29.9	255	0.527**	421	0.388**
30.0–39.9	276	0.613**	617	0.392**
40.0–49.9	405	0.354**	625	0.397**
50.0–59.9	434	0.585**	492	0.395**
≥ 60	468	0.524**	460	0.328**
All ages (≥ 18.0)	1838	0.509**	2615	0.359**

**Pearson's correlation is significant at $P < 0.01$ level (2-tailed).

resilient to the insults of malnutrition and disease than is that of males. More studies are needed to investigate the effects of CED in adults on morbidity and mortality risks in developing countries.

A matter of concern in relations to CED is the finding of a relatively high proportion of CED among the elderly (≥ 60 years). Approximately 23 and 27% of the elderly men and women, respectively, can be classified as CED, reflective of low fat and lean body masses. Since these subjects are from lower socioeconomic communities, there is concern for the general welfare and health care of the elderly, especially if they are living by themselves. The rapid pace of urbanization and industrialization that has taken place in the past two decades or so have 'pulled' the younger age groups to the cities, resulting in many villages with mainly middle-aged and older inhabitants.

The proportion of underweight among the elderly may be higher because BMI tends to underestimate the prevalence of CED. Using height to calculate BMI for the elderly is inappropriate due to height loss associated with ageing, including changes in the vertebral skeleton with osteopaenia and increased curvature (kyphosis). Armspan and knee-height are alternative options to estimate stature in the elderly since these measurements involve the long bones, which do not lose length with ageing.[17]

Co-existing with the problem of CED in older female subjects is the problem of high WHR, indicative of central obesity. It is known that significant changes occur in body composition with ageing. Adipogenesis increases, accompanied by fat redistribution whereby proportionately more body fat is located internally rather than subcutaneously. The WHR is often used as an index of fat distribution in cross-sectional studies although it is not appropriate for evaluating changes in weight loss that are associated with loss of visceral fat.[18] This study recorded 39.5% of the elderly women with WHR in excess of the cut-off point of 0.85. A smaller prevalence of the elderly men (5.5%) were in excess of the cut-off point of 1.0. The difference may be related to a survival effect in that men with higher WHR also have associated higher risks of mortality due to cardiovascular diseases, diabetes stroke and cancer.[19]

While it is recognized that, in certain cases, an increase in abdominal circumference with age may reflect shortening of the trunk due to osteoporosis or other spinal deformities,[10] the question, nonetheless, as to whether the cut-off point of 0.85 is appropriate for use in the elderly has been raised in light of findings of a high prevalence of the elderly being at risk, based on WHR. In a large study on white and black women aged 45–64 years, it was reported that 50% had WHR that exceeded 0.85.[20] In a study on women aged ≥ 60 years,[21] two thirds of white women and almost 90% of black women were found to equal or exceed the WHR cutoff of 0.80. The authors suggested that perhaps the high prevalence of high WHR among older USA women is a function of the

Table 12. Mean body mass index (kg/m^2) by gender, age and type of community

Age (years)	Fishing	Rice farming	Rubber small-holding	Coconut small-holding	Estates	All communities
Men						
18.0–39.9	22.6 ± 3.6 (97)^a	22.3 ± 3.7 (134)^b	21.6 ± 3.5 (116)^a	22.9 ± 4.8 (69)^{a,b}	23.4 ± 4.2 (125)^b	22.5 ± 3.9 (541)^a
40.0–59.9	23.9 ± 4.1 (159)^b	22.2 ± 3.5 (192)^b	22.7 ± 3.5 (207)^b	23.4 ± 4.1 (190)^b	23.4 ± 3.7 (96)^b	23.1 ± 3.8 (844)^b
≥ 60.0	21.9 ± 3.8 (68)^a	20.9 ± 3.4 (117)^a	20.9 ± 3.0 (125)^a	22.1 ± 4.1 (148)^a	20.3 ± 2.6 (14)^a	21.4 ± 3.6 (472)^c
Women						
18.0–39.9	24.6 ± 5.3 (252)^a	23.0 ± 4.4 (292)^b	23.0 ± 4.3 (242)^b	23.8 ± 4.3 (140)^a	23.7 ± 4.8 (206)^{a,b}	23.6 ± 4.7 (1132)^a
40.0–59.9	26.1 ± 4.9 (217)^b	23.7 ± 4.8 (305)^b	23.6 ± 4.6 (302)^b	25.7 ± 4.7 (229)^b	25.2 ± 5.1 (93)^b	24.6 ± 4.9 (1146)^b
≥ 60.0	24.0 ± 5.1 (79)^a	20.6 ± 3.9 (138)^a	21.3 ± 4.5 (131)^a	23.8 ± 5.3 (113)^a	22.4 ± 3.9 (12)^a	22.2 ± 4.8 (473)^c

Values represent mean ± SD (number of subjects); values with no common superscript in the same column are significantly different ($P < 0.05$) by Duncan's multiple-range test.

Table 13. Mean waist-to-hip ratio by gender, age and type of community

Age (years)	Fishing	Rice farming	Rubber small-holding	Coconut small-holding	Estates	All communities
Men						
18.0–39.9	0.88 ± 0.1 (97)^a	0.86 ± 0.1 (130)^a	0.86 ± 0.1 (116)^a	0.84 ± 0.1 (67)^a	0.87 ± 0.1 (124)^a	0.86 ± 0.1 (539)^a
40.0–59.9	0.93 ± 0.1 (159)^b	0.89 ± 0.1 (193)^b	0.90 ± 0.1 (208)^b	0.89 ± 0.1 (191)^b	0.91 ± 0.1 (97)^b	0.90 ± 0.1 (848)^b
≥ 60.0	0.93 ± 0.1 (67)^b	0.89 ± 0.1 (119)^b	0.88 ± 0.1 (125)^c	0.87 ± 0.1 (149)^{ab}	0.88 ± 0.1 (14)^a	0.88 ± 0.1 (474)^c
Women						
18.0–39.9	0.77 ± 0.1(240)^a	0.79 ± 0.1 (270)^a	0.78 ± 0.1 (221)^a	0.79 ± 0.1 (129)^a	0.80 ± 0.1 (184)^a	0.78 ± 0.1 (1044)^a
40.0–59.9	0.80 ± 0.1 (216)^b	0.81 ± 0.1 (293)^b	0.80 ± 0.1 (300)^b	0.81 ± 0.1 (223)^b	0.83 ± 0.1 (94)^a	0.81 ± 0.1 (1126)^b
≥ 60.0	0.82 ± 0.1 (82)^c	0.83 ± 0.1 (138)^c	0.81 ± 0.1 (128)^b	0.86 ± 0.1 (112)^c	0.86 ± 0.1 (8)^b	0.83 ± 0.1 (468)^c

Values represent mean ± SD (number of subjects); values with no common superscript in the same column are significantly different ($P < 0.05$) by Duncan's multiple-range test.

normal ageing process, and for healthy elderly free of CVD risk factors, exceeding the WHR cutoff may be unrelated to survival.

The use of waist circumference alone as an index of intra-abdominal fat mass has been highlighted in recent reports including the World Health Organization (WHO) Consultation Report on Obesity.[2] Waist circumference correlates closely with BMI and WHR and is also sensitive to changes in risk factors of cardiovascular disease, diabetes and other forms of chronic non-communicable disease. The appropriate cut-off point for waist circumference especially for older persons needs to be established.

The present study shows an increase in the prevalence of pre-obese and obese rural Malay adults over the past few decades. Overall, approximately one in five men and one in four women are pre-obese, while another 4% of the men and 10% of the women are obese. The numbers of pre-obese and obese men and women were found to be highest in the 40.0–49.9 years age group.

The prevalence of obesity in Malaysia appears to be higher than the levels in other Asian countries such as Thailand, China and Japan, but lower than for Western Pacific countries such as Australia and New Zealand.[22] A study on Thai officials aged 35 to 54 years found that 2.2% of the 2703 men and 3.0% of the 792 women had BMI ≥ 30 kg/m^2, as reported by the WHO.[2] In China, the prevalence of obesity was reported as low at 1.2% and 1.6%, respectively, for men and women aged 20–45.[23] The prevalence of obesity in Japan is also reported as low, that is, 1.7% in men and 2.7% in women aged above 20 years.[2] In contrast, the proportion of obesity in Western Pacific countries has been found to be relatively higher. In a study on Australian adults, 11.5% of men and 13.2% of women aged 25–64 were found to be obese,[24] while a study on New Zealand men and women reported 55% men and 38% women had BMI exceeding 25.0 kg/m^2.[25]

However, caution needs to be exercised in inferring obesity from BMI findings in different ethnic populations. It is known that Asians tend to have shorter legs in relation to trunk compared with Australian Aborigines and people of African ancestry with longer legs in relation to trunk. Thus, an individual of the same weight but with shorter legs will have a higher BMI than the individual with longer legs due to body shape. Also, since BMI reflects body fat mass as well as lean body mass, the same BMI value can represent different body composition, especially in different ethnic populations. For example, studies among Asian population groups showed a higher fat level at any given BMI compared with Caucasians.[26]

In conclusion, this study showed that the problems of chronic energy deficiency and overweight exist side by side in adults from rural communities. The high prevalence of CED in older persons and that of overweight and obesity in middle-aged and older female subjects underscore the need for sensitive health promotion activities. Obesity is no longer an urban problem but has extended to rural communities. National healthy lifestyle campaigns in Malaysia that normally carry a single blanket message should take cognizance of the dual forms of malnutrition in coexistence.

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