Original Article

Nutritional assessment of rural villages and estates in peninsular Malaysia: Total blood cholesterol values in children, adolescents and adults*

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The present study is unique in the Malaysian context on two counts; first, it employs for the first time a functional group approach (groups based on occupational or economic activity) in the assessment of community nutritional status. Second, the study provides on a nationwide-sampling basis, information on total blood cholesterol (TC) levels in rural children (7.0–12.9 years; n = 1921) and adolescents (13.0–17.9 years; n = 753) which were hitherto unavailable. Total blood cholesterol measurements were performed on 7184 subjects ranging from 7 to 75-years-old (males = 3151; females = 4033) from households in 69 rural villages and seven estates in peninsular Malaysia, which were based on selected multistage random sampling according to the household's involvement in the following economic activities: rice farming, rubber smallholding, coconut smallholding, fishing and employment in estates. In all functional groups, TC values increased with age and there was a distinct gender effect, namely females had higher TC values than males throughout the age spectrum analyzed. Mean TC levels for children and adolescents were in the range 3.85–4.37 mmol/L, rising markedly during adulthood to an overall mean of 4.91 ± 1.13 mmol/L for men and 5.17 ± 1.11 mmol/L for women. In adults (≥ 18.0 years), there was marked disparity in mean TC values among the functional groups; males and females from rice households had the lowest mean TC values (4.58 and 4.99 mmol/L, respectively). Individuals at 'high risk' (TC > 6.20 mmol/L) averaged 16.0% in women and 11.6% in men, with women from the fishing, rubber and coconut households particularly affected (17.1–21.1%). When compared to earlier rural TC data reported for closely similar rural communities in the peninsula, the present findings suggest a 'hypercholesterolemic shift' approximating 0.39 mmol/L (15 mg/dL) in the adult population; however, this was not apparent in the children and adolescents from these rural communities.

Key words: adolescents, adults, children, cholesterol, Malaysia.

Introduction

Transition in socioeconomic status coupled with changes in lifestyles have probably contributed a major part to the infamous position of cardiovascular diseases (CVD) as the 'number one killer' in Malaysia since the late 1980s. This prompted the Ministry of Health Malaysia to launch the Healthy Lifestyle Campaign in 1991 with the first annual theme 'Prevention of CVD'. Today, CVD still accounts for about 27.6% of all medically certified deaths in the country, with heart diseases and cardiovascular disorders the main component, contributing to about 20.0% of total mortality.[1]

Epidemiological studies have established that ischemic heart disease (IHD) has a multifactorial etiology, involving risk factors such as genetic predisposition, hypercholesterolemia, obesity, sedentary lifestyle and diabetes. The risk of death from IHD in adult men from western industrialized nations is low when total blood cholesterol (TC) levels are below 4.65 mmol/L, while this mortality risk increases fourfold for TC levels rising from 5.17 mmol/L to 7.76 mmol/L.[2,3] It has also been shown that for every 1% reduction in TC, there is a 2% reduction in IHD risk.[4] These observations have prompted the National Cholesterol Education Program (NCEP) in the US to classify plasma cholesterol values below 5.17 mmol/L as 'desirable'.[5] The health benefit of low TC levels is also reminiscent of the Malaysian study, which showed that the Orang Asli who lived in interior jungle areas had low TC values and did not suffer from heart disease.[6]

As fatty streaks can be seen in early childhood, the importance of maintaining 'desirable' TC levels throughout adolescence and adulthood is viewed as a primary prevention strategy against the development of IHD, the clinical symptoms of which usually surface during middle age or later in

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life. Available evidence indicates that dietary fats and cholesterol are not the only 'key players' in the whole diet–heart disease cascade. There is now compelling evidence to suggest the involvement of several other micronutrients, some of which are anti-oxidants, which can prevent the oxidation of low-density lipoproteins (LDL),[7,8] or inhibit protein kinase C activity and thus smooth muscle cell proliferation.[9]

Previous reports on TC values in Malaysian populations have been provided mainly by Chong and Khoo,[10] Chong, *et al.*,[11] and Khoo *et al.*[12] The early data of Chong and Khoo[10] was essentially 'urban', as was the data of Khoo *et al.*[12] Chong *et al.*'s study,[11] conducted by the Institute for Medical Research (IMR) during 1979–83 in four states in the peninsula, represented rural data. However, the number of subjects measured for TC was small, as venipuncture was used in blood collection. In contrast, the present study utilized the finger-prick technique in blood collection and provided the largest rural sample on TC values to date, particularly that for Malaysian children and adolescents, which have not been reported on this scale elsewhere. The 'functional group' classification approach and the meticulous multistage sampling design used in the selection of rural households from which the individuals for the TC assay were obtained, represented a 'first' in the country for such data.

Methods

Selection of study locations

The Farmers' Census of 1990 provided by the Ministry of Agriculture Malaysia, containing the acreage under different crops in 80 districts in peninsula Malaysia, served as the sampling frame for the selection of rice farmers, rubber smallholders and coconut smallholders; the 'Fisherman Association Areas 1991' from the Fisheries Development Authority Malaysia, the sampling frame for fishing villages; and a list of estates from the National Union of Plantation Workers (NUPW), the sampling frame for estates. A total of 69 rural villages and seven estates were randomly selected for the study. Details of the multistage sampling technique used to select randomly 600 households for each of the functional groups have been described previously.[13]

Total blood cholesterol assays

At each selected village, TC screening was done at a central workstation, often from 09.00 hours to 18.30 hours. Following registration and anthropometric measurements, random blood samples from subjects above 7 years were collected by Weisbaden finger-prick into heparinized tubes and analyzed immediately for TC using reagent strips specific for use with the Reflotron analytical system (Boehringer Mannheim, Wiesbaden, Germany). The non-fasting blood specimens would not affect the TC values.[14,15] As the top layer of the reagent strip used filtered off the blood cells, the final blood fraction analyzed by the system was actually plasma. When the results of the TC assays were ready, the subjects were examined by a medical doctor where medical/dietary advice would be given, if necessary.

Subjects examined at the workstation were matched against a household list for the functional group concerned, which contained details of household heads and members. Efforts were then made to re-invite 'defaulting' individuals/households to call at the work station to be examined. Overall, 3151 males and 4033 females, aged 7–75 years, who visited the workstations set up in the 69 villages and seven estates by the investigators and their collaborators, were measured for TC. The TC values from pregnant women were excluded from the analysis as these values would be elevated during the second to third trimesters.

In our hands, the use of quality control (QC) sera (Humatrol N; Boehringer Mannheim) indicated that the Reflotron 'dry chemistry' system used was capable of an analytical performance represented by a coefficient of variation (CV) of < 3.0% in the reference lipid laboratory at the IMR, and a CV of about 5.0% under the field conditions experienced during the study (data not shown). The QC data obtained agrees with the findings of a multicentre study on the performance of the Reflotron analytical system.[16] Nevertheless, we found that it was necessary to prevent ambient workstation temperatures approximating 34°C, above which the analytical system shut down. This 'threshold' temperature in situations of an extremely hot workstation was avoided by improving the ventilation to the instrument.

Statistical analysis

The differences in TC values between males and females within each age group or for combined data were analyzed by the Student's *t*-test with significance level at $P < 0.05$. Differences in TC means among the functional groups were compared by ANOVA using the Duncan multiple-range test.

Results

Profile of the subjects measured for total blood cholesterol

From the 69 rural villages and seven estates selected in the study, a total of 7184 subjects were screened for TC. Their demographic profiles are shown in Table 1. During the TC screening at the villages selected for the different functional groups, it was not uncommon to obtain 100% coverage of the households identified. However, it was noted that there was a significant number of 'defaulters' from the study households due to various reasons, while subjects from 'non-selected' households in the village were also welcome to be examined at the workstation. Overall coverage of members from selected households in the study was estimated to be 50–60%. Some selection bias is expected from the failure to screen all members of selected households, as reflected by the apparent increased proportion of elderly subjects

Table 1. Profile of subjects measured for total blood cholesterol by age and sex

Age (years)	Male		Female	
	n[a]	BMI[b]	*n*	BMI
7.0–12.9	980	—	941	—
13.0–17.9	357	—	396	—
18.0–29.9	249	21.4	463	22.2
30.0–39.9	272	23.6	652	24.6
40.0–49.9	405	23.4	635	25.0
50.0–59.9	424	22.7	476	24.2
≥ 60.0	464	21.4	470	22.1
Overall	3151	22.5[c]	4033	23.8[c]

[a]Number of subjects; [b]Mean body mass index (BMI) from data of Khor *et al.*;[19] [c]Mean for adults only; —, data not available.

(≥ 60 years), which now approximates that of the adults 18.0–59.9 years old.

Total blood cholesterol values according to age and sex

Overall, TC levels increased with age, which was evident in both male and female subjects throughout the age spectrum analyzed, with the exception of a decline in TC levels observed in males above 60 years old (Fig 1). These observations are consistent with the findings on the association of TC values with age in other studies.[10,17] Interestingly, TC values in females were markedly higher than in the males for each age category. This trend was apparent in all the age groups studied, and was consistent with a similar observation among 3600 subjects drawn from 14 rural 'poverty kampungs' in the states of Kelantan, Johore, Kedah and Perak during 1979–83.[11]

As expected, the mean TC values in Malaysian rural children and adolescents reported here are in the 'healthy' range (< 5.17 mmol/L) of 3.85–4.37 mmol/L. Unlike the increase in serum TC with age seen in the adults (≥ 18.0 years), there seems little rise in mean TC levels between the ages of 7.0 and 17.9 years (Fig 1). Interestingly, there was a dip in TC values obtained for the male adolescents (mean = 3.85 mmol/L), which was also seen in both male and female adolescents in the Lipid Research Clinics Study data.[4]

The mean TC values obtained for the age groups–children (7.0–12.9 years), adolescents (13.0–17.9 years), adults (18.0–59.9 years), and the elderly (≥ 60 years) were only marginally higher than their respective median values, that is the 50th percentiles (Table 2). This indicates that the TC values in the various age groups analyzed approximated Gaussian-type normal distributions. A similar association between mean and median TC values for different age groups was also observed in the Lipid Research Clinics Study,[4] which lend creditibility to the present data set.

Comparison among functional groups

The mean TC levels differ among the functional groups studied, particularly so in the adult males ≥ 18.0 years; Table 3. Adult men from rice households had the most favorable mean TC values, namely 4.27–4.86 mmol/L, which are associated with 'low risk';[5] the overall mean of 4.59 mmol/L was significantly lower ($P < 0.05$) than the corresponding mean values of 4.96–5.09 mmol/L for the other four functional groups studied.

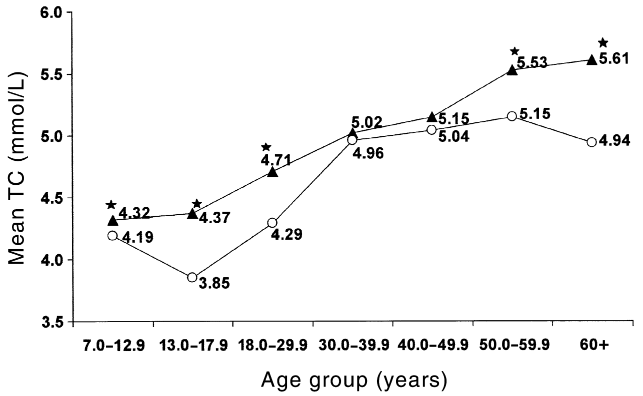

Figure 1. Mean serum TC in rural males (○) and females (▲) according to age group. *Significantly higher than in males for the same age group.

Table 2. Total blood cholesterol (TC) mean values and percentiles according to age group and sex

Age group (years)	Mean ± SD (mmol/L)	Percentile TC values			
		50th	75th	90th	95th
7.0–12.9					
M	4.19 ± 0.82	4.14	4.63	5.17	5.46
F	4.42 ± 0.85	4.27	4.78	5.38	5.74
13.0–17.9					
M	3.85 ± 0.90	3.80	4.37	4.96	5.43
F	4.37 ± 0.82	4.32	4.81	5.33	5.82
18.0–59.9					
M	4.91 ± 1.13	4.81	5.58	6.39	7.03
F	5.09 ± 1.11	5.02	5.74	6.46	7.08
≥ 60					
M	4.94 ± 1.08	4.89	5.61	6.31	6.80
F	5.61 ± 1.16	5.56	6.23	7.14	7.60

M, male; F, female.

Despite having the largest proportion of young adults, the estate group had a significantly higher mean TC than the rice group (4.91 ± 1.21 *vs*. 4.50 ± 0.98 mmol/L, $P < 0.05$); Table 3. Therefore, the results clearly indicated that besides age and gender, the functional group had a significant influence on mean TC values in the present study.

The decline in TC levels among men in the highest age category used, namely ≥ 70 years, was clearly seen in the rice, estate and fishing functional groups, which is consistent with the observation reported earlier for all elderly men (≥ 60 years old) combined. Interestingly, this TC pattern was not observed in men from the rubber and coconut households, where there was no sign of TC decline in men ≥ 70 years old.

Adult females from the rice and estate households had significantly lower mean TC levels than did the women from the other functional groups (5.04 and 5.02 mmol/L compared with 5.28 and 5.35 mmol/L, respectively $P < 0.05$; Table 4). Rice-growing seems to be associated with low TC levels in both rural adult men and women, but the rationale for this is unclear. However, it is hypothesized that the simple traditional lifestyles often associated with remote rice-growing households in the peninsula may be a contributory factor.

As observed earlier, the TC values in children were significantly higher than in adolescents ($P < 0.05$). This phenomenon was seen in the males (Fig 2) but not in the females (Fig 3) for all the functional groups investigated. The reason for this dip in TC values in the male adolescents could be due in part to their expected higher activity compared to the female adolescents. Interestingly, TC values were lowest in the male adolescents from rice-growing households, as was also observed for the men in this functional group.

Risk classification by total blood cholesterol

Under the NCEP classification,[5] TC values < 5.17 mmol/L are considered 'desirable', 5.17–6.20 mmol/L 'borderline–high risk', and > 6.20 mmol/L 'high risk'.[5] Thus, TC values ≥ 5.17 mmol/L are considered as 'raised'. This has caused some confusion among some local investigators who had used the cut-off of ≥ 5.17 mmol/L to denote 'hyper-

Table 3. Mean total blood cholesterol (TC) values by age among men according to functional group

Functional group	Age category (years) 18.0–39.9	40.0–49.9	50.0–59.9	60.0–69.9	≥ 70.0
Rice	4.50 ± 0.98[a]	4.71 ± 1.16[a]	4.63 ± 0.93[a]	4.86 ± 1.11[a]	4.27 ± 0.82[a]
Rubber	4.65 ± 1.24[ab]	4.94 ± 1.08[ab]	5.22 ± 1.26[b]	4.99 ± 1.21[a]	4.99 ± 1.11[b]
Coconut	4.45 ± 1.03[a]	5.17 ± 1.08[b]	5.12 ± 0.90[b]	5.15 ± 0.95[a]	5.04 ± 0.95[b]
Estate	4.91 ± 1.21[b]	5.17 ± 0.90[b]	5.25 ± 1.06[b]	5.09 ± 0.62[a]	4.55 ± 0.54[ab]
Fishing	4.63 ± 1.24[ab]	5.27 ± 1.47[b]	5.51 ± 1.47[b]	5.17 ± 1.18[a]	4.89 ± 1.18[ab]

TC values given as mean ± SD; mmol/L. Values with different superscript in the same column are significantly different ($P < 0.05$) by the Duncan multiple-range test.

Table 4. Mean total blood cholesterol (TC) values by age among women according to functional group

Functional group	Age category (years) 18.0–39.9	40.0–49.9	50.0–59.9	60.0–69.9	≥ 70.0
Rice	4.73 ± 1.03[a]	4.89 ± 1.13[a]	5.22 ± 0.98[a]	5.46 ± 1.16[ab]	5.51 ± 1.24[a]
Rubber	4.86 ± 1.16[ab]	5.15 ± 1.03[ab]	5.64 ± 1.21[ab]	5.61 ± 1.24[ab]	6.00 ± 1.11[a]
Coconut	4.96 ± 1.11[b]	5.30 ± 1.08[b]	5.64 ± 1.13[ab]	5.77 ± 1.11[b]	5.22 ± 1.31[a]
Estate	4.94 ± 0.87[ab]	5.04 ± 0.95[ab]	5.35 ± 1.06[ab]	4.84 ± 0.41[a]	5.48 ± 1.00[a]
Fishing	4.96 ± 1.11[b]	5.27 ± 1.29[b]	5.74 ± 1.39[b]	5.58 ± 0.95[ab]	6.13 ± 1.13[a]

TC values given as mean ± SD; mmol/L. Values with different superscript in the same column are significantly different ($P < 0.05$) by the Duncan multiple-range test.

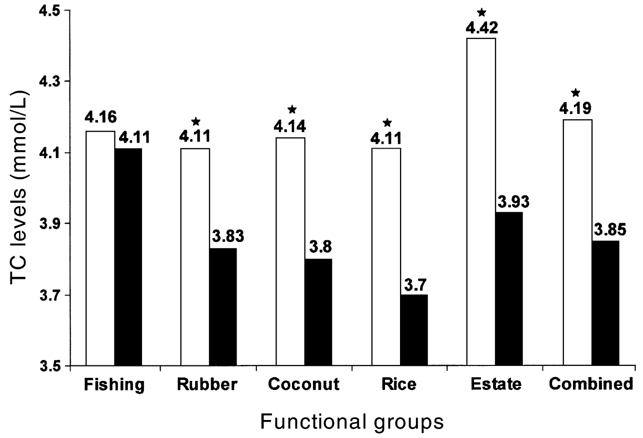

Figure 2. TC levels among rural boys according to functional group. (□) 7.0–12.9 years; (■) 13.0–17.9 years. *$P < 0.05$ for within functional group comparison.

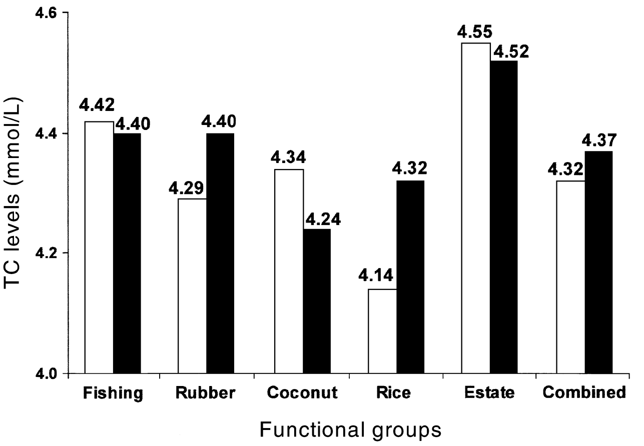

Figure 3. TC levels among rural girls according to functional group. (□) 7.0–12.9 years; (■) 13.0–17.9 years.

cholesterolemia' and this is probably inappropriate. The use of a higher cut-off of '> 6.20 mmol/L' in screening programs to identify adult subjects with 'increased risk' or 'high risk', that is hypercholesterolemics who warrant some form of intervention, has been recommended. This level is equivalent to slightly more than mean + 1SD in the present data set for adults (Table 2), and takes into account the biological and analytical variations inherent in the TC assays and thus avoids the possible inclusion of a large number of 'false positives', which would otherwise occur with the '5.17 mmol/L' cut-off.[18]

Of interest, the percentile distribution of TC values for apparently healthy rural adults as shown in Table 2, suggests that the cut-off values for 'high risk' should be much higher than > 6.20 mmol/L, particularly for women. However, the cut-off of > 6.20 mmol/L for 'high risk' has been used here so that there is compatibility with the NCEP classification, which has been adopted by most clinicians in the country following a consensus meeting by the Ministry of Health Malaysia and the Academy of Medicine Malaysia on the Management of Hyperlipidemias in 1993.

Overall, the prevalence of 'high risk' was 11.6% in men and 16.0% in women, but there was great disparity among the different functional groups (Table 5). In the rubber, coconut and rice functional groups, the prevalence of 'high risk' females was twice that in the males. Interestingly, 27.8 and 10.6% of the women were overweight and obese, respectively, whereas the corresponding figures in the men were 19.8 and 4.2%, respectively.[19] The generally higher BMI values in the women compared to the men (23.8 *vs*. 22.5 kg/m^2) in the present data set may help to explain their higher TC values. This scenario underscores the rapid emergence of risk factors of IHD in the general rural adult population, particularly in women, in the peninsula.

As expected from the comparatively low mean TC values in the rice functional group, the prevalence of 'high risk' adults was also lowest in this group (males = 5.7%; females

Table 5. Risk classification based on total blood cholesterol (TC) values in rural men and women

Functional group	*n*	≤ 5.17 mmol/L %	5.18–6.20 mmol/L %	> 6.20 mmol/L %
Fishing				
M	321	57.0	24.9	18.1
F	549	49.4	33.5	17.1
Rubber				
M	444	63.1	25.0	11.9
F	666	50.3	29.0	20.7
Coconut				
M	409	58.7	30.1	11.2
F	483	49.5	29.4	21.1
Rice				
M	405	74.8	19.5	5.7
F	688	59.6	29.5	10.9
Estate				
M	235	59.6	27.6	12.8
F	310	60.0	32.6	7.4
Total				
M	1814	63.2	25.3	11.6
F	2696	53.4	30.6	16.0

M, male; F, female.

= 10.9%). However, adults from fishing households had the highest proportion of adults at ‘high risk’ (males = 17.1%; females = 18.1%). This latter observation with subjects from fishing households represents a discrepancy, as one would expect members from such households to have a high-fish diet, which is associated with low plasma lipids as seen in Inuit and Japanese populations.[20]

As TC increases with age, it is clear that the risk classification used for adults is not appropriate for children and adolescents, an issue which has been raised previously.[10] Using the data in Table 2 and applying the same rationale as used for adults, it is recommended that the TC cut-off value for ‘increased risk’ in children and adolescents be 5.17 mmol/L, which approximates the combined TC mean + 1SD for these age groups (children + adolescents).

‘Hypercholesterolemic shift’

As is evident in Table 6, when subjects are matched for age group mean TC values in male and female adults above 30 years old in the present study are 0.13–0.47 mmol/L higher than the corresponding TC values reported in the rural study of Chong *et al.*,[11] when subjects are matched for age group. This was so, despite the fact the venous samples used in the earlier study are generally expected to give marginally higher values than are capillary blood samples[14] analyzed in the present study. It must be emphasized that the present data set does not represent longitudinal data, and thus the ‘hypercholesterolemic shift’ referred to is only apparent. However, the justification for a similar comparison was reported earlier by Ng *et al.*[21] when they highlighted the apparent nutritional transition among adults in three rural villages in Bagan Datoh, Perak which formed part of the present data pool from 69 rural villages and seven estates.

The TC data of Khoo *et al.*,[12] obtained by the same Reflotron analytical system during several campaigns of National Heart Week in urban towns in the peninsula during 1992–94, as well TC values in Americans,[5] have been reproduced in Table 6 for comparison. The mean TC values of the rural adults in the present study are intermediate to the corresponding values reported in the earlier rural study of Chong *et al.*[11] and the urban data of Khoo *et al.*[12]

Discussion

The present TC data set represents the largest ever reported for Malaysian children (7.0–12.9 years; *n* = 1921) and adolescents (13.0–17.9 years; *n* = 753) from a single study. The interest in obtaining TC values for the above younger age groups stems primarily from the concern that such data are not readily available for Malaysians, and that TC concentrations measured in old age may not be representative of a lifetime exposure, which may therefore attenuate the TC–IHD association.

The results showed that serum TC values of men start to peak at about 40 years of age, while in women this phenomenon occurs some 10 years later, that is at 50 years of age. This may be due to the cholesterolemic impact of menopause on TC and low density lipoprotein cholesterol in women.[22] While this may explain the higher TC levels in women than in men when comparing subjects above 50 years of age, the rationale for the same phenomenon in the younger age groups is unclear.

For the purpose of comparison, the proportion of adults in each age group should ideally be standardized across functional groups, because age influenced TC values. In adults, this point is particularly important for the lowest age group (18.0–39.9 years) and to a lesser extent, the highest age group (≥ 70 years) where mean TC values appeared lower than the other four intermediate decade-age categories within each functional group. However, the omission of the above standardization in the present study due to practical constraints is not expected to affect the overall finding for the comparatively low mean TC values in the rice functional group, as the proportion (29.4%) of young adults aged 18.0–39.9 years in this function group was comparable to that in the fishing (29.6%) and rubber (25.4%) functional groups, but

Table 6. Mean total blood cholesterol (TC) of Malaysian adults from rural villages versus 'urban' data

Age group (years)	Rural villages Chong *et al.*[11]		Rural villages present study		Urban towns Khoo *et al.*[12]		US population* NCEP, 1988[5]
	n	Mean	*n*	Mean	*n*	Mean	Mean
18.0–29.9							
M	95	4.16	249	4.29	385	4.83	4.91
F	252	4.76	463	4.71	(M + F)		4.86
30.0–39.9							
M	76	4.68	272	4.96	745	5.14	5.38
F	171	4.86	652	5.02	(M + F)		5.17
40.0–49.9							
M	44	4.91	405	5.04	565	5.46	5.74
F	75	4.68	635	5.15	(M + F)		5.66
50.0–59.9							
M	31	4.86	424	5.15	321	5.61	5.90
F	32	5.33	476	5.53	(M + F)		6.20
≥ 60							
M			464	4.94	154	5.61	5.71
F			470	5.61	(M + F)		6.36

*Estimated from reference cited; Mean (TC) values are given as mmol/L; NCEP, National Cholesterol Education Program; M, male; F, female; M + F, males and females; blanks due to no data.

approximated half the proportion in the estate group (53.2%; data not shown).

Concomitant with this apparent rise in TC levels, overweight (body mass index (BMI) 25.0–29.9) and obesity (BMI ≥ 30.0) have become major public health problems among the adult population in these rural communities. About 19.8% were overweight and 4.2% obese in males, while 27.8% were overweight and 10.6% obese in females.[21]

The apparent hypercholesterolemic shift when the adult TC data in the present study are compared to that of Chong *et al.* conducted during 1979–83 may be expected and can generally be attributed to changes in lifestyles that accompany socioeconomic development. However, this adverse TC trend need not be the price Malaysians should pay as the nation heads toward 2020 and a developed nation status. This inference stems from a recent report by the National Heart, Lung, and Blood Institute (NHLBI) that TC levels in the general US population have declined by 0.26 mmol/L from the period 1976–80 to 1988–94, apparently due to the combined effects of a reduction in the consumption of total fat, saturated fats and cholesterol.[23] Similarly, recent findings from the Third National Health and Nutrition Examination Survey (NHANES) conducted by the National Centre for Health Statistics, USA, showed that TC values in adolescents have declined from 4.32 mmol/L in the late 1960s to 4.14 mmol/L for the period 1988–94.[23] Comparable longitudinal Malaysian data on children and adolescents are unavailable but it is hoped that the current Healthy Lifestyle Campaign Phase II of the Ministry of Health Malaysia, focused on changing behaviour, would have a similar beneficial impact of lowering TC levels in the general population.

Conclusion

Overall, the findings showed considerable disparity in TC levels among the adults in the various functional groups; men from rice households had mean TC significantly lower than that of males in the other functional groups (4.58 mmol/L) (4.97–5.04 mmol/L; $P < 0.05$). A gender effect on TC levels was especially evident in the functional groups — rubber, coconut and rice — where mean TC values for females were 0.31–0.41 mmol/L higher ($P < 0.05$), and the prevalence of 'high risk' (> 6.18 mmol/L) twice that of the males in the respective functional groups. Compared to TC data obtained from rural communities about 15 years ago, the present findings for mean TC in men (4.91 ± 1.14 mmol/L) and women (5.17 ± 1.11 mmol/L) were much higher and represent an apparent 'hypercholesterolemic shift' equivalent to about 0.39 mmol/L (15 mg/dL).

Mean TC levels in children and adolescents were comparatively low (3.85–4.37 mmol/L), particularly in adolescent males, which was a common phenomenon in all the functional groups studied. These TC levels rose steadily in adulthood, peaking from the ages of 40 and 50 years, for men and women, respectively.

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