Distribution of Blood Total Cholesterol in a National Sample of Malaysian Adults

T O Lim, MRCP*, L M Ding, MHA*, M Zaki, FRCP**, A B Suleiman, FRACP**, S T Kew, FRCP***, M Ismail, FRCP***, A H Maimunah, MPH****, B Rugayah, MPH****, H Rozita, MPH****, * Clinical Research Centre, ** Department of Nephrology, ***Department of Medicine, Jalan Pahang, 50586 Kuala Lumpur, **** Institute Kesihatan Umum, Kuala Lumpur

Summary

We describe the distribution of capillary blood total cholesterol (BC) by age, sex and ethnicity in Malaysian adults. A national sample of 20041 individuals aged 30 or older had usable data. They were selected by stratified 2-stage cluster sampling. BC was measured using reflectance photometer. Percentile tables and curves by age, sex and ethnicity are presented. The BC distribution was right skewed and showed the expected increase with age. There were ethnic differences. Malay had the highest BC concentration, followed by Indian, Chinese and other indigenous ethnic group. However, for all ethnic groups, BC concentrations were low in comparison those prevailing in Western populations.

Key Words: Blood total cholesterol, Population survey, Distribution

Introduction

The distribution of blood total cholesterol (BC) in a representative national sample of Malaysian adults has not previously been described. Such information is of epidemiological interest, and is also useful in public health practice.

High levels of BC are associated with increase risk of cardiovascular morbidity[1]. Information on distribution of BC is therefore useful for describing hypercholesterolaemia related health burden in a population as well as for planning prevention strategy.

We present here the distribution of BC by age, sex and ethnicity using the data from the National Health and Morbidity survey (NHMS) completed in 1996.

Materials and Methods

Sampling design and sample

The NHMS was a multi-purpose health survey designed to describe the health status, health related behaviour and health services utilisation for a representative sample of the population of Malaysia. An up to date and representative sampling frame for this population was provided by the frame used by the annual Labour Force survey conducted by the Department of Statistics[2]. The sampling frame was stratified by state and urban/rural residence. A stratified two stage cluster sampling design with self-weighting sample was used to draw a sample of 17995 private dwellings. However, only 13025(87%) of dwellings were contactable or responded. All residents of sampled dwellings were included yielding a sample size of 59903 individuals. For NHMS

component on blood total cholesterol, 23034 individuals aged 30 or older were eligible. 20041 (87%) of them agreed to have their measurements taken or had evaluable measurements. Table I and II show the composition of the sample.

Capillary blood total cholesterol measurement

Blood total cholesterol was measured by a trained nurse using reflectance photometer (Accutrend, Boehringer Mannheim). The procedure was explained and verbal permission obtained from the respondent prior to the examination. Blood sample was obtained by finger prick and a small droplet of blood was then placed on a test

Table I
Characteristics of Respondents Compared with Total Population of Malaysia Aged 30 or Older in 1996

	Respondents (unweighted) n=20041 No. (%)	Malaysia Population Aged 30 or Older n=7.84 million %
Sex		
Men	9330 (47%)	50%
Women	10711 (53%)	50%
Age		
30 - 34	3989 (20%)	21%
35 - 39	3699 (18%)	19%
40 - 44	3127 (16%)	16%
45 - 49	2487 (12%)	12%
50 - 54	1827 (9%)	9%
55 - 59	1558 (8%)	7%
60 - 64	1278 (6%)	6%
65 - 69	882 (4%)	4%
>=70	1194 (6%)	6%
Ethnic groups		
Malay	9171 (46%)	43%
Chinese	5415 (27%)	31%
Indian	1348 (7%)	8%
Other indigenous	3074 (15%)	9%
Others	1033 (5%)	10%

strip. The strip was then inserted into the photometer for total cholesterol measurement. Respondents were informed of their blood cholesterol values and referred to a nearest health facility for follow up if their BC exceeded 6mmol/L. All nurses attended centralised training on standardised protocol for BC measurement. During field survey, supervisors conducted weekly check on compliance with BC measurement protocol.

The reflectance photometer has lower and upper detection limits of 3.88 to 7.75mmol/L respectively. Beyond the limits, measurements are recorded as 'lo' and 'hi'. Its precision and accuracy were deemed satisfactory for survey use. Reported within-run coefficient of variation was less than 5%[3]. Compared with results obtained with the cholesterol oxidase/p-aminophenazone method using capillary sera, the correlation coefficients varied from 0.91 - 0.92, and systematic differences (bias) varied from +2.5% to -3.2%[3].

Definitions

For purpose of analysis, blood total cholesterol levels were categorised as desirable (BC<5.2mmol/L), borderline high (BC 5.2 - 6.2mmol/L), and high blood cholesterol (BC>=6.2mmol/L), according to the classification system recommended by the Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol[4].

Statistical methods

Probability weighted estimation was used to obtain all estimates as appropriate for the sampling design[5,6]. The sampling weights were adjusted for household non-response using adjustment cells formed by state and urban/rural residence. Post stratification[7] was used to adjust the weighted sample totals to known population totals for age, gender and ethnicity based on 1996 census population projection.

Since the total cholesterol measurement has a lower and upper detection limit, 'lo' values were regarded as left-censored at 3.88 and 'hi' values right-censored at 7.75mmol/L. For estimating means, we assume the log-transformed blood cholesterol values are distributed as truncated Normal[8,9]. The method is sensitive to the distributional assumption. We tested against departure

Table II
Sample Size by Age, Sex and Ethnicity in the Survey

	Malay	Chinese	Indian	Other indigenous
Men, age in years				
30 - 34	762	386	125	315
35 - 39	749	384	144	266
40 - 44	667	381	118	226
45 - 49	556	368	72	137
50 - 54	401	282	43	148
55 - 59	379	225	34	89
60 - 64	272	178	33	96
65 - 69	205	135	26	51
>=70	246	147	30	101
Women, age in years				
30 - 34	953	495	159	417
35 - 39	934	498	153	331
40 - 44	823	472	109	197
45 - 49	588	393	87	195
50 - 54	434	293	45	117
55 - 59	380	241	56	109
60 - 64	308	198	49	104
65 - 69	213	143	28	64
>=70	301	196	37	111

from normality using the test described by Chesher and Irish[10]. Overall, ethnic and sex specific means and percentages were standardised by the direct method to the age distribution of the 1996 adult Malaysian population S-Plus[11] and STATA[12] software packages were used for analysis.

Results

Percentiles distribution

The percentiles of BC by age, gender and ethnicity are shown in tables III to X. In men from all ethnic groups, BC rose with age till age 50 and declined thereafter. In contrast, cholesterol levels continued to rise with increasing age in women.

Geometric mean blood cholesterol

Tables XI to XII show the geometric mean blood cholesterol(BC) by gender, ethnicity and age. In all ethnic groups except other indigenous below age 50, men had higher mean BC than women and the reverse was true after age 50. Other indigenous men and women had the lowest mean BC than both sexes of the other 3 ethnic groups for all age groups.

Percentage distribution of blood cholesterol

Table XIII and XIV show the percentage distribution of BC according to the classification recommended by the Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol[4]. Overall, 5% of the adult population had high blood cholesterol, 15% borderline high and 85% had BC in the desirable range. Malay had the highest prevalence of age-adjusted prevalence of high blood cholesterol, followed by Indian, Chinese, and other indigenous ethnic group the lowest.

Table III
Empirical Percentiles of Blood Cholesterol for Malay Males, by Age

Age Group	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	>=70
n	762	749	667	556	401	379	272	205	246
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
20.00th	<=3.9	<=3.9	<=3.9	4.0	4.0	<=3.9	<=3.9	<=3.9	<=3.9
25.00th	<=3.9	4.1	4.1	4.1	4.1	4.0	4.0	4.0	<=3.9
30.00th	4.0	4.2	4.2	4.2	4.2	4.1	4.1	4.1	<=3.9
35.00th	4.1	4.3	4.3	4.3	4.3	4.3	4.2	4.2	4.0
40.00th	4.2	4.3	4.4	4.4	4.4	4.4	4.3	4.3	4.0
45.00th	4.3	4.4	4.5	4.6	4.5	4.4	4.4	4.4	4.2
50.00th	4.4	4.5	4.6	4.7	4.6	4.5	4.5	4.5	4.3
55.00th	4.5	4.6	4.7	4.7	4.7	4.7	4.7	4.5	4.3
60.00th	4.6	4.7	4.8	4.8	4.8	4.8	4.8	4.7	4.4
65.00th	4.7	4.8	4.9	5.0	4.9	4.9	4.9	4.7	4.6
70.00th	4.8	4.9	5.1	5.1	5.0	5.0	5.0	4.8	4.7
75.00th	4.9	5.0	5.2	5.2	5.1	5.2	5.1	4.9	4.8
80.00th	5.1	5.1	5.3	5.5	5.3	5.5	5.2	5.0	5.0
85.00th	5.3	5.3	5.6	5.7	5.5	5.6	5.3	5.3	5.1
90.00th	5.6	5.6	5.8	5.9	5.9	6.1	5.5	5.6	5.3
95.00th	6.1	6.1	6.3	6.6	6.4	6.7	5.9	6.1	5.8

Table IV
Empirical Percentiles of Blood Cholesterol for Malay Females, by Age

Age Group	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	>=70
n	953	934	823	588	434	380	308	213	301
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	4.0	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	4.1	<=3.9	4.2	4.1	<=3.9
20.00th	<=3.9	<=3.9	<=3.9	4.0	4.3	4.1	4.3	4.2	4.0
25.00th	4.0	4.0	4.0	4.2	4.3	4.3	4.5	4.3	4.1
30.00th	4.1	4.1	4.1	4.3	4.4	4.4	4.6	4.5	4.3
35.00th	4.2	4.2	4.3	4.3	4.5	4.5	4.7	4.6	4.4
40.00th	4.3	4.3	4.3	4.5	4.6	4.6	4.8	4.7	4.6
45.00th	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.8	4.6
50.00th	4.4	4.5	4.5	4.7	4.9	4.9	5.0	4.9	4.7
55.00th	4.5	4.6	4.6	4.7	5.0	5.0	5.1	5.1	4.8
60.00th	4.6	4.7	4.7	4.8	5.1	5.1	5.2	5.2	4.9
65.00th	4.7	4.8	4.8	4.9	5.2	5.3	5.3	5.3	5.0
70.00th	4.8	4.9	4.9	5.1	5.3	5.5	5.4	5.4	5.2
75.00th	4.9	5.0	5.0	5.2	5.4	5.7	5.6	5.6	5.3
80.00th	5.1	5.1	5.1	5.4	5.6	5.9	5.7	5.8	5.5
85.00th	5.2	5.3	5.3	5.6	6.0	6.2	5.9	6.0	5.7
90.00th	5.4	5.5	5.5	5.8	6.5	6.7	6.3	6.2	6.1
95.00th	5.9	6.0	5.9	6.4	7.0	7.2	6.9	6.8	6.5

Discussion

We advise caution in interpreting the results. The stability of the centile estimates is assured only if based on large sample sizes. This was clearly the case for Malay, Chinese and other indigenous ethnic group's estimates. However sample sizes for Indian in the older age groups (age 60 - 70+) were small. One should also be cautious in interpreting cross sectional data longitudinally. In particular, the tendency of the rise in BC with age to flatten or even reverses beyond age 50 - 60 in men should not be interpreted as due to ageing effect. One alternative explanation is selective survival. People with lower BC tend to survive with increasing age thus shifting the BC distribution of survivors downwards. Cross sectional data as presented here cannot differentiate the individual contribution of ageing and selective survival.

Characteristics of the BC distribution of the Malaysian population, as shown here, largely resemble those observed in other substantial population surveys[13-15]. The right skewed or log-normal distribution, the rise in BC with age, differences between the 2 sexes and variation among the ethnic groups are all well described characteristics of population BC distribution. The most notable findings are the remarkably low BC prevailing in all ethnic groups in our population. This is in sharp contrast to Western populations, and is comparable to other non-western populations. For example, the mean serum cholesterol in the U.S. adult population[13] was 5.4mmol/L In contrast the corresponding figure in Malaysia as shown in this study was 4.5mmol/L and that of mainland urban Chinese was 4.2 mmol/L[15].

The BC distribution of Malaysian adults described here is not merely of epidemiological interest. It is useful in its own right. In public health practice, the planning of any prevention strategy must take into account the burden of illness due to any risk factor in the community. Population BC distribution can help in estimating the burden of illness due to hypercholesterolaemic related morbidity in the population. In the planning of cholesterol screening programme, information on BC distribution in the population is required for resource planning. The available resources must match the number of individuals in the population targeted for intervention, the number in turn depends on the population BC distribution.

To our knowledge, this is the first detailed description of BC distribution in a representative national sample of Malaysian adults. The distribution can serve as a baseline for comparison with future repeat survey to determine the effectiveness of intervention programme in shifting the population BC distribution in a favourable direction. The population BC distribution described here can also serve as a yardstick for assessing the representativeness of sample in small survey. The BC distribution of a representative sample should closely match that described here.

In conclusion, we found the distribution of BC of Malaysian adults was shifted toward the lower end compared with those in Western populations. Detailed description of BC distribution in our population is useful for public health practice.

Acknowledgement

Table V
Empirical Percentiles of Blood Cholesterol for Chinese Males, by Age

Age Group n Percentiles	30-34 386	35-39 384	40-44 381	45-49 368	50-54 282	55-59 225	60-64 178	65-69 135	>=70 147
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	4.0	4.0	<=3.9	<=3.9
20.00th	<=3.9	<=3.9	4.0	4.0	4.1	4.1	4.1	<=3.9	<=3.9
25.00th	4.0	4.1	4.1	4.1	4.2	4.2	4.2	4.0	<=3.9
30.00th	4.1	4.2	4.2	4.2	4.3	4.2	4.3	4.2	4.0
35.00th	4.2	4.3	4.3	4.3	4.5	4.3	4.4	4.3	4.1
40.00th	4.3	4.4	4.4	4.4	4.6	4.4	4.4	4.4	4.2
45.00th	4.3	4.5	4.5	4.5	4.6	4.4	4.5	4.6	4.2
50.00th	4.4	4.6	4.6	4.6	4.7	4.5	4.6	4.6	4.3
55.00th	4.5	4.7	4.7	4.7	4.8	4.6	4.6	4.7	4.4
60.00th	4.6	4.8	4.8	4.8	4.8	4.7	4.8	4.7	4.5
65.00th	4.7	4.8	4.9	4.9	4.9	4.8	4.8	4.8	4.6
70.00th	4.8	4.9	5.0	4.9	5.0	5.0	5.0	5.0	4.7
75.00th	4.9	5.0	5.2	5.0	5.1	5.1	5.2	5.0	4.8
80.00th	5.0	5.2	5.3	5.2	5.3	5.2	5.3	5.1	4.9
85.00th	5.2	5.4	5.5	5.4	5.5	5.3	5.4	5.2	5.1
90.00th	5.4	5.7	5.8	5.6	5.7	5.6	5.7	5.4	5.2
95.00th	5.6	6.1	6.2	6.2	6.1	6.1	6.2	5.8	5.7

Table VI
Empirical Percentiles of Blood Cholesterol for Chinese Females, by Age

Age Group n Percentiles	30-34 495	35-39 498	40-44 472	45-49 393	50-54 293	55-59 241	60-64 198	65-69 143	>=70 196
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	4.0	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	4.0	4.1	4.1	4.1	4.0	4.1
20.00th	<=3.9	<=3.9	4.0	4.1	4.2	4.3	4.2	4.1	4.1
25.00th	<=3.9	4.0	4.1	4.2	4.3	4.4	4.4	4.3	4.2
30.00th	4.0	4.1	4.2	4.3	4.4	4.6	4.6	4.4	4.3
35.00th	4.1	4.2	4.3	4.4	4.5	4.7	4.7	4.5	4.4
40.00th	4.2	4.3	4.4	4.5	4.7	4.8	4.8	4.6	4.5
45.00th	4.3	4.3	4.5	4.6	4.8	4.9	4.9	4.7	4.6
50.00th	4.4	4.4	4.5	4.7	4.9	5.0	5.0	4.9	4.7
55.00th	4.5	4.5	4.7	4.7	5.0	5.1	5.0	5.0	4.8
60.00th	4.5	4.6	4.8	4.8	5.1	5.2	5.1	5.1	4.9
65.00th	4.6	4.7	4.8	4.9	5.2	5.4	5.2	5.1	5.0
70.00th	4.8	4.8	4.9	5.0	5.3	5.5	5.4	5.3	5.0
75.00th	4.8	4.9	5.0	5.1	5.4	5.6	5.5	5.4	5.1
80.00th	5.0	5.0	5.1	5.3	5.7	5.8	5.8	5.5	5.3
85.00th	5.1	5.2	5.3	5.4	5.8	5.9	6.1	5.7	5.5
90.00th	5.3	5.4	5.5	5.7	6.2	6.2	6.4	6.0	6.0
95.00th	5.5	6.0	5.7	6.2	6.6	6.7	7.0	6.8	6.5

Table VII
Empirical Percentiles of Blood Cholesterol for Indian Males, by Age

Age Group n	30-34 125	35-39 144	40-44 118	45-49 72	50-54 43	55-59 34	60-64 33	65-69 26	>=70 30
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	4.0	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	4.2	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
20.00th	<=3.9	<=3.9	4.1	4.3	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
25.00th	4.0	4.1	4.2	4.3	4.2	<=3.9	<=3.9	4.1	<=3.9
30.00th	4.1	4.1	4.3	4.4	4.4	4.0	<=3.9	4.3	<=3.9
35.00th	4.1	4.4	4.4	4.6	4.5	4.4	<=3.9	4.3	<=3.9
40.00th	4.3	4.4	4.6	4.7	4.7	4.5	4.1	4.3	4.1
45.00th	4.3	4.5	4.6	4.8	4.8	4.5	4.4	4.5	4.3
50.00th	4.4	4.6	4.7	5.1	4.9	4.7	4.4	4.5	4.3
55.00th	4.4	4.8	4.7	5.3	4.9	4.8	4.5	4.8	4.3
60.00th	4.6	4.8	4.8	5.3	4.9	4.8	4.6	4.9	4.4
65.00th	4.7	4.9	5.0	5.4	5.0	5.0	4.7	4.9	4.4
70.00th	4.8	5.0	5.1	5.5	5.3	5.0	4.8	4.9	4.5
75.00th	4.9	5.0	5.3	5.6	5.4	5.3	4.9	4.9	4.5
80.00th	5.0	5.2	5.5	6.0	5.4	5.4	4.9	5.0	4.8
85.00th	5.2	5.4	5.8	6.2	5.4	5.6	5.1	5.7	5.1
90.00th	5.4	5.6	6.3	6.6	5.9	6.3	5.7	5.7	5.1
95.00th	6.0	6.2	7.0	7.2	7.0	6.7	6.9	5.8	5.2

Table VIII
Empirical Percentiles of Blood Cholesterol for Indian Females, by Age

Age Group n	30-34 159	35-39 153	40-44 109	45-49 87	50-54 45	55-59 56	60-64 49	65-69 28	>=70 37
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	4.2	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	4.0	<=3.9	4.3	<=3.9
20.00th	<=3.9	<=3.9	<=3.9	4.1	4.0	4.0	<=3.9	4.3	4.0
25.00th	4.0	4.0	4.0	4.3	4.4	4.2	<=3.9	4.4	4.1
30.00th	4.0	4.1	4.0	4.4	4.4	4.4	4.0	4.5	4.2
35.00th	4.1	4.2	4.1	4.5	4.5	4.4	4.2	4.5	4.4
40.00th	4.1	4.3	4.2	4.6	4.6	4.7	4.3	4.6	4.5
45.00th	4.2	4.3	4.4	4.7	4.6	4.8	4.4	4.8	4.6
50.00th	4.3	4.4	4.5	4.8	4.7	4.9	4.4	4.9	4.7
55.00th	4.4	4.5	4.6	4.9	4.7	5.0	4.7	5.0	4.8
60.00th	4.4	4.6	4.6	4.9	4.8	5.2	4.7	5.0	5.0
65.00th	4.5	4.6	4.7	5.0	4.9	5.2	4.7	5.1	5.1
70.00th	4.7	4.7	4.9	5.1	5.0	5.3	4.8	5.1	5.3
75.00th	4.7	4.8	4.9	5.2	5.1	5.6	5.0	5.2	5.3
80.00th	4.9	4.9	5.0	5.4	5.2	5.7	5.2	5.3	5.5
85.00th	5.0	5.2	5.3	5.6	5.3	5.7	5.3	5.3	5.9
90.00th	5.2	5.4	5.5	5.7	5.8	5.9	5.8	5.6	6.2
95.00th	5.5	5.9	5.9	6.2	6.4	6.3	6.0	6.0	6.8

Table IX
Empirical Percentiles of Blood Cholesterol for Other Indigenous Males, by Age

Age Group	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	>=70
n	315	266	226	137	148	89	96	51	101
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
20.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
25.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
30.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
35.00th	<=3.9	4.0	4.0	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
40.00th	<=3.9	4.1	4.1	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
45.00th	4.0	4.2	4.2	4.1	<=3.9	<=3.9	4.0	<=3.9	<=3.9
50.00th	4.1	4.3	4.3	4.2	4.0	<=3.9	4.2	<=3.9	<=3.9
55.00th	4.2	4.3	4.3	4.3	4.1	4.0	4.2	4.0	<=3.9
60.00th	4.3	4.4	4.4	4.3	4.3	4.1	4.3	4.2	4.1
65.00th	4.4	4.6	4.6	4.5	4.4	4.3	4.4	4.4	4.1
70.00th	4.5	4.7	4.7	4.5	4.5	4.3	4.4	4.4	4.3
75.00th	4.6	4.8	4.8	4.6	4.6	4.3	4.5	4.6	4.3
80.00th	4.7	4.9	4.9	4.8	4.9	4.4	4.6	4.7	4.6
85.00th	4.9	5.1	5.2	5.1	5.0	4.5	4.8	4.8	4.8
90.00th	5.1	5.5	5.5	5.2	5.1	4.8	4.9	4.9	4.9
95.00th	5.7	6.2	6.0	5.5	5.7	5.0	5.7	5.3	5.2

Table X
Empirical Percentiles of Blood Cholesterol for Other Indigenous Females, by Age

Age Group	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	>=70
n	417	331	197	195	117	109	104	64	111
Percentiles									
5.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
10.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
15.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
20.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9
25.00th	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	<=3.9	4.1	<=3.9
30.00th	<=3.9	<=3.9	<=3.9	<=3.9	4.0	4.0	4.0	4.2	<=3.9
35.00th	4.0	4.1	<=3.9	4.0	4.0	4.1	4.1	4.3	4.0
40.00th	4.1	4.1	4.1	4.1	4.2	4.3	4.2	4.4	4.2
45.00th	4.2	4.2	4.1	4.3	4.3	4.4	4.3	4.5	4.3
50.00th	4.3	4.3	4.2	4.4	4.4	4.6	4.4	4.5	4.3
55.00th	4.4	4.4	4.3	4.5	4.6	4.6	4.5	4.6	4.4
60.00th	4.5	4.6	4.4	4.6	4.7	4.8	4.5	4.7	4.5
65.00th	4.6	4.7	4.5	4.7	4.8	4.9	4.6	4.8	4.6
70.00th	4.7	4.8	4.7	4.8	4.9	5.0	4.8	4.8	4.8
75.00th	4.8	4.9	4.8	4.9	5.0	5.2	4.9	5.2	4.9
80.00th	4.9	5.0	4.8	5.0	5.2	5.4	5.1	5.4	5.1
85.00th	5.1	5.2	5.1	5.2	5.2	5.6	5.4	6.1	5.3
90.00th	5.3	5.3	5.3	5.5	5.5	6.0	5.6	6.6	5.3
95.00th	5.7	5.9	5.6	6.3	6.2	6.6	6.3	6.9	5.6

Table XI
Crude and Age-adjusted Mean Capillary Blood Cholesterol

	Crude Mean (SE)	Age Adjusted Mean (SE)
All	4.5 (0.01)	4.5 (0.01)
men	4.5 (0.01)	4.5 (0.01)
women	4.6 (0.01)	4.6 (0.01)
Malay	4.6 (0.01)	4.6 (0.01)
men	4.5 (0.02)	4.5 (0.19)
women	4.6 (0.01)	4.6 (0.18)
Chinese	4.6 (0.01)	4.6 (0.01)
men	4.5 (0.02)	4.5 (0.21)
women	4.6 (0.02)	4.6 (0.2)
Indian	4.5 (0.03)	4.6 (0.03)
men	4.6 (0.05)	4.6 (0.31)
women	4.5 (0.04)	4.5 (0.28)
Other indigenous	4.2 (0.02)	4.2 (0.02)
men	4.1 (0.03)	4.1 (0.24)
women	4.3 (0.03)	4.3 (0.24)

Table XII
Age Specific Mean Capillary Blood Cholesterol

		Age-Group	Mean (SE)
Malay	men	30 - 39	4.5 (0.02)
		40 - 49	4.6 (0.03)
		50 - 59	4.6 (0.04)
		60 - 69	4.5 (0.04)
		>=70	4.2 (0.06)
Malay	women	30 - 39	4.5 (0.02)
		40 - 49	4.6 (0.02)
		50 - 59	4.9 (0.04)
		60 - 69	5.0 (0.04)
		>=70	4.7 (0.06)
Chinese	men	30 - 39	4.5 (0.03)
		40 - 49	4.6 (0.03)
		50 - 59	4.6 (0.04)
		60 - 69	4.6 (0.05)
		>=70	4.3 (0.07)
Chinese	women	30 - 39	4.4 (0.03)
		40 - 49	4.6 (0.03)
		50 - 59	4.9 (0.04)
		60 - 69	4.9 (0.06)
		>=70	4.7 (0.07)
Indian	men	30 - 39	4.5 (0.05)
		40 - 49	4.9 (0.08)
		50 - 59	4.7 (0.12)
		60 - 69	4.4 (0.14)
		>=70	4.2 (0.16)
Indian	women	30 - 39	4.4 (0.05)
		40 - 49	4.6 (0.06)
		50 - 59	4.7 (0.10)
		60 - 69	4.6 (0.09)
		>=70	4.7 (0.17)
Other indigenous	men	30 - 39	4.1 (0.04)
		40 - 49	4.2 (0.05)
		50 - 59	3.9 (0.06)
		60 - 69	4.0 (0.09)
		>=70	3.8 (0.11)
Other indigenous	women	30 - 39	4.3 (0.03)
		40 - 49	4.2 (0.05)
		50 - 59	4.4 (0.07)
		60 - 69	4.5 (0.08)
		>=70	4.3 (0.09)

Table XIII
Crude and Age-adjusted Percentage Distribution of Blood Cholesterol
According to NCEP* Classification

Cholesterol (mmol/L)	% Normal (SE) <5.2	Age-adjusted % Normal (SE)	% Borderline (SE) 5.2-6.2	Age-adjusted % Borderline (SE)	% High (SE) >=6.2	Age-adjusted % High (SE)
All	80.0 (0.4)	80.0 (0.3)	15.0 (0.3)	15.0 (0.3)	5.0 (0.2)	5.0 (0.2)
men	81.5 (0.5)	81.5 (0.5)	14.0 (0.4)	13.9 (0.4)	4.5 (0.3)	4.5 (0.2)
women	78.5 (0.5)	78.6 (0.4)	16.0 (0.4)	15.9 (0.4)	5.5 (0.3)	5.5 (0.2)
Malay	78.0 (0.5)	78.0 (0.5)	16.0 (0.4)	16.0 (0.4)	6.0 (0.3)	6.0 (0.3)
men	79.6 (0.7)	79.6 (0.7)	14.9 (0.6)	14.9 (0.6)	5.5 (0.4)	5.5 (0.4)
women	76.4 (0.7)	76.5 (0.7)	17.1 (0.6)	17.1 (0.6)	6.4 (0.4)	6.4 (0.4)
Chinese	79.4 (0.7)	79.9 (0.6)	16.0 (0.6)	15.7 (0.5)	4.6 (0.3)	4.5 (0.3)
men	80.7 (0.9)	80.9 (0.9)	15.6 (0.8)	15.3 (0.8)	3.8 (0.4)	3.7 (0.4)
women	78.1 (0.9)	78.9 (0.8)	16.4 (0.8)	16.0 (0.7)	5.5 (0.5)	5.1 (0.4)
Indian	79.1 (1.5)	79.1 (1.2)	15.8 (1.3)	15.8 (1.1)	5.1 (0.7)	5.2 (0.7)
men	76.4 (2.0)	76.6 (1.7)	16.8 (1.6)	16.7 (1.5)	6.8 (1.1)	6.8 (1.1)
women	81.8 (1.6)	81.5 (1.5)	14.7 (1.4)	14.9 (1.4)	3.5 (0.7)	3.6 (0.7)
Other indigenous	87.5 (0.7)	87.5 (0.7)	9.2 (0.6)	9.3 (0.6)	3.3 (0.4)	3.3 (0.3)
men	90.2 (0.9)	90.2 (0.8)	7.0 (0.7)	7.1 (0.7)	2.7 (0.5)	2.7 (0.5)
Women	84.7 (1.1)	84.8 (1.0)	11.4 (0.9)	11.4 (0.8)	3.8 (0.5)	3.8 (0.5)

*NCEP: National Cholesterol Education Program. Report of the Expert Panel on detection, evaluation and treatment of high cholesterol in adults[4]

Table XIV
Age Specific Percentage Distribution of Blood Cholesterol According to NCEP* Classification

Cholesterol		Age Group	% Normal (SE) <5.2	% Borderline (SE) 5.2 - 6.2	% High (SE) >=6.2
Malay	men	30 - 39	82.3 (1.0)	13.1 (0.9)	4.6 (0.7)
		40 - 49	75.2 (1.3)	18.5 (1.2)	6.2 (0.7)
		50 - 59	76.8 (1.7)	14.9 (1.4)	8.3 (1.1)
		60 - 69	82.0 (2.0)	13.9 (1.7)	4.2 (0.9)
		>=70	85.6 (2.5)	11.8 (2.3)	2.7 (1.0)
	women	30 - 39	83.7 (1.0)	13.0 (0.8)	3.2 (0.4)
		40 - 49	79.2 (1.1)	16.2 (1.1)	4.7 (0.6)
		50 - 59	64.4 (1.8)	21.6 (1.6)	14.0 (1.3)
		60 - 69	61.8 (2.4)	27.8 (2.2)	10.4 (1.4)
		>=70	72.6 (2.8)	18.2 (2.3)	9.2 (1.9)
Chinese	men	30 - 39	82.9 (1.5)	13.7 (1.4)	3.4 (0.7)
		40 - 49	78.3 (1.7)	17.0 (1.5)	4.6 (0.8)
		50 - 59	78.1 (2.1)	18.4 (1.9)	3.5 (0.9)
		60 - 69	79.4 (2.6)	16.6 (2.4)	3.9 (1.3)
		>=70	90.2 (2.5)	7.5 (2.3)	2.3 (1.3)
	women	30 - 39	87.1 (1.2)	10.7 (1.1)	2.2 (0.5)
		40 - 49	81.7 (1.4)	14.5 (1.3)	3.8 (0.7)
		50 - 59	62.7 (2.2)	27.7 (2.2)	9.6 (1.4)
		60 - 69	65.6 (2.8)	22.6 (2.6)	11.8 (1.8)
		>=70	77.5 (3.4)	14.7 (2.7)	7.8 (2.6)
Indian	men	30 - 39	82.6 (2.4)	14.1 (2.1)	3.3 (1.3)
		40 - 49	64.3 (3.9)	23.4 (3.3)	12.3 (2.6)
		50 - 59	71.0 (5.0)	19.3 (4.5)	9.7 (3.5)
		60 - 69	84.2 (4.7)	11.4 (4.3)	4.4 (3.0)
		>=70	96.1 (2.9)	3.9 (2.9)	0.0 (0.0)
	women	30 - 39	88.4 (2.1)	9.7 (1.8)	1.9 (0.7)
		40 - 49	80.1 (2.8)	16.5 (2.6)	3.3 (1.3)
		50 - 59	73.2 (4.8)	20.5 (4.5)	6.3 (2.5)
		60 - 69	77.8 (4.6)	18.8 (4.4)	3.4 (2.1)
		>=70	69.5 (8.2)	20.6 (7.1)	9.9 (5.0)
Other indigenous	men	30 - 39	89.8 (1.4)	6.4 (1.1)	3.8 (0.9)
		40 - 49	87.2 (1.8)	10.1 (1.6)	2.8 (1.0)
		50 - 59	93.5 (1.7)	5.4 (1.6)	1.1 (0.6)
		60 - 69	91.8 (2.2)	6.5 (2.0)	1.7 (1.1)
		>=70	96.2 (1.9)	3.0 (1.8)	0.8 (0.8)
	women	30 - 39	87.0 (1.4)	10.6 (1.3)	2.4 (0.6)
		40 - 49	87.1 (1.8)	9.2 (1.6)	3.6 (1.0)
		50 - 59	79.5 (3.0)	14.8 (2.5)	5.8 (1.7)
		60 - 69	79.0 (3.2)	12.7 (2.5)	8.3 (2.1)
		>=70	83.6 (3.6)	15.5 (3.6)	0.9 (0.8)

*NCEP: National Cholesterol Education Program. Report of the Expert Panel on detection, evaluation and treatment of high cholesterol in adults[4]

References

1. Stamler J, Wentworth D, Neaton J. Is the relationship betwen serum cholesterol and the risk of deaths from coronary heart disease continuous and graded? JAMA 1986; 256: 2823-8.

2. Labour Force Survey Report 1995, Department of Statistics. Kuala Lumpur.

3. Gottschling HD, Reuter W, Ronquis G, et al. Multicentre evaluation of a non-wipe system for rapid determination of total cholesterol in capillary blood, Accutrend cholesterol on Accutrend GC. Eur J Clin Chem Clin Biochem 1995; 33: 373-81.

4. National Cholesterol Education Program. Report of the Expert Panel on detection, evaluation and treatment of high cholesterol in adults. Arch Intern Med 1988; 148: 36-9.

5. Cochran WG. Sampling techniques. Third edition, Wiley 1977.

6. Lehtonen R, Pahkinen E. Practical methods for design and analysis of complex surveys. Wiley 1996.

7. Kessler RC, Little RJA, Groves RM. Advances in strategies for minimizing and adjusting for survey nonresponse. Epidemiologic Reviews 1995; 17: 192-204.

8. Heckman J. The common structure of statistical models of truncation, sample selection and limited dependent variables and a simple estimator of such models. Ann Econ Soc Measure 1976; 5: 475-92.

9. Breen R. Regression models : censored, sample selected or truncated data. Sage University Paper series on Quantitative Applications in the Social sciences, 07-111, Thousand Oaks, CA: Sage.

10. Chesher A, Irish M. Residual analysis in the grouped and censored linear normal model. J Econometrics 1987; 34: 33-61.

11. Statistical Sciences, S-PLUS guide to statistical and mathematical analysis, Version 3.3, Seattle: StatSci, a division of MathSoft, Inc, 1995.

12. Statacorp 1997. Stata Statistical Software: Release 5.0 College Station, TX: Stata Corporation.

13. National Center for health Statistics. Total serum cholesterol levels of adults 20 to 74 years of age : U.S. 1976-1980, Vital and Health Statistics, ser.II, No. 236. Dept of Health and Human Services publication PHS 86-1686. Government printing office, May 1986.

14. Heiss G, Tamir I, Davis CE, et al. Lipoprotein cholesterol distribution in selected North American populations: the Lipid Research Clinics Program Prevalence survey. Circulation 1980; 61: 302-15.

15. Chen Z, Peto R, Collins R, et al. Serum cholesterol concentration and coronary heart disease in population with low cholesterol concentrations. Br Med J 1991; 303: 276-82.