The lipid and lipoprotein profile of the urban black South African population of the Cape Peninsula — the BRISK study

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Objective. To determine the lipid and lipoprotein profile of the urban black South African population of the Cape Peninsula.

Design. Cross-sectional design.

Setting. The seven black residential areas of the Cape Peninsula.

Participants. A stratified proportional sample was drawn from the study area. The sample consisted of 422 men and 544 women aged between 15 and 64 years.

Outcome measures. Lipid and lipoprotein levels. Risk levels for coronary heart disease (CHD).

Results. The total cholesterol (TC level) was low compared with other South African groups studied. Men had a mean TC of 3.98 mmol/l and women 4.15 mmol/l. Low-density lipoprotein cholesterol (LDLC) values for men (2.03 mmol/l) were lower than those for women (2.30 mmol/l). Men (1.35 mmol/l) and women (1.37 mmol/l) had similar high-density lipoprotein cholesterol (HDLC) levels. Both sexes had a prevalence of protective HDL/TC ratios above 30% for all age groups. High HDL_3C levels and low HDL_2C levels were found in both men and women. Apolipoprotein A and B followed the trends of HDLC and LDLC and showed no difference between the sexes. The plasma triglyceride (TG) levels increased with age in both sexes. Men displayed higher TG levels than women in all age groups. Seventeen per cent of men and 26% of women had a moderate-to-high risk for CHD, given their TC levels. Other lipid-related risk factors indicated low risk for CHD.

Conclusions. This population had low TC, LDLC and favourable HDLC/TC ratios. There were, however, individuals with high lipid levels, especially women in the older age groups. A much higher percentage of cholesterol was carried in the HDL_3C subfraction than was found in other studies. This difference in distribution of cholesterol among HDL_2C and HDL_3C, compared with other studies, should be investigated further.

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There is a lack of data on the lipid and lipoprotein profile of a representative sample of black South Africans. A number of small studies, quite dated and unable adequately to define the lipid levels of black South Africans, reported a protective lipid and lipoprotein profile associated with their low prevalence of coronary heart disease (CHD).[1-4]

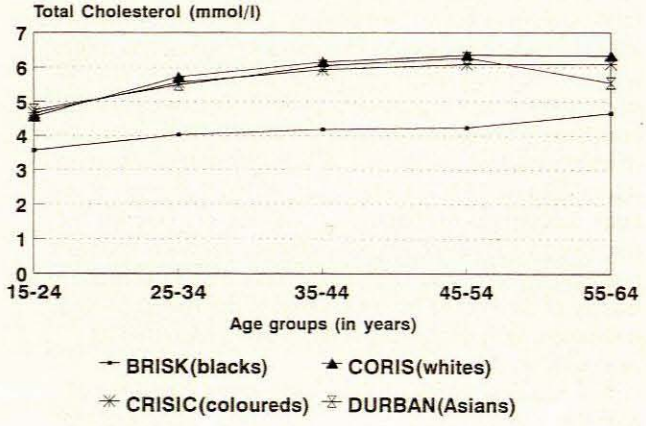

Fig. 1. Mean total cholesterol (TC) concentration of four population groups (men).

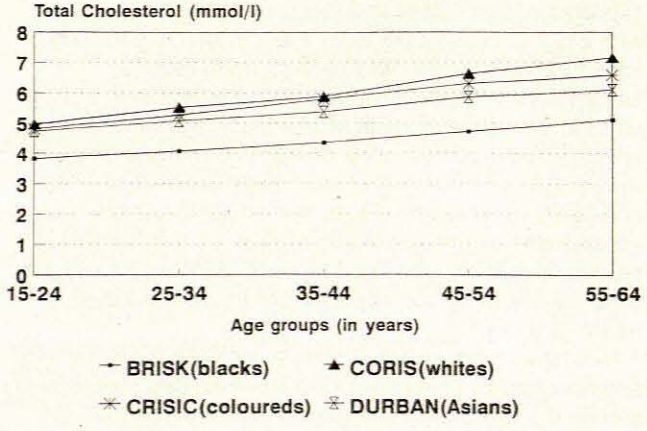

Fig. 2. Mean total cholesterol (TC) concentration of four population groups (women).

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The transition from a rural to an urban lifestyle has been shown to impact negatively on the lipid and lipoprotein profile of communities undergoing such change.[5] An unfavourable lipid profile is one of the known primary and independent risk factors for CHD.[6] The aim of this study was to determine the lipid and lipoprotein profile of a representative sample of urban black South Africans, a group currently undergoing rapid urbanisation, and to establish to what extent it poses a risk for CHD. This information may facilitate a plan of action to prevent hyperlipidaemia and ischaemic heart disease (IHD) from reaching epidemic proportions, as has been the case among the white and Asian populations of South Africa and the black population of America.

Methods

Subjects

The study population comprised black South Africans aged 15 - 64 years who resided in the seven townships in the Cape Peninsula. From this population, a stratified proportional sample of 442 men and 544 women was drawn. In addition to the biochemical measurements, information about family history of hypercholesterolaemia as well as knowledge of participants' own cholesterol levels and risk for IHD were obtained by questionnaire through personal interviews. The sampling procedures and fieldwork have been described elsewhere.[7] Only one person per household was selected. Households included both formal and informal dwellings from all socio-economic strata of the townships.

Lipids and lipoproteins

Non-fasting blood samples were drawn into EDTA 1 mg/ml with minimum stasis, centrifuged, the plasma stored at 4°C and analysed within 24 hours. Plasma total cholesterol (TC) and high-density lipoprotein cholesterol (HDLC) levels were measured on a Gilford batch analyser using the Boehringer Mannheim CHODPAP enzymatic method (cat. no. 290319). HDLC was measured after precipitation of the apolipoprotein B (apo-B)-containing lipoproteins with heparin/manganese chloride. Preciset Cholesterol Standard (cat. no. 709905) was used to calibrate the Gilford batch analyser. In each batch analysed, Boehringer Precinorm L (cat. no. 781827) was used as an external control, and pooled plasma as an internal control. HDL_3C was determined after precipitation with dextran sulphate and HDL_2C was calculated by subtracting HDL_3C from total HDLC. LDLC was calculated using the Friedewald formula (TC – HDLC – TG/5).[8] This formula was applied if the plasma triglyceride (TG) concentration did not exceed 4.5 mmol/l (400 mg/dl). Plasma apo-A1 and plasma apo-B were assayed by laser nephelometry using anti-human apo-A1 and -B nonspecific antisera, raised in sheep (Boehringer Mannheim cat. nos 726478 and 726494 respectively). Plasma TG concentration was determined by the Boehringer Mannheim enzymatic Peridochrom method (cat. no. 701882).

Results

Mean lipid levels as well as the percentiles of TC, LDLC and HDLC/TC of the BRISK (risk factors for coronary heart disease in Cape Peninsula blacks) population are given in Tables I to IV according to age and sex. Among men and

Table I. Descriptive statistics of lipid risk factors (mean (SD))

	Men — age groups (yrs)					
	15 - 24 (*N* = 150)	25 - 34 (*N* = 110)	35 - 44 (*N* = 84)	45 - 54 (*N* = 56)	55 - 64 (*N* = 42)	15 - 64 (*N* = 442)
TC (mmol/l)	3.57 (0.89)	4.02 (0.81)	4.19 (1.47)	4.24 (0.97)	4.66 (0.71)	3.98 (1.05)
LDLC (mmol/l)	1.83 (0.79)	2.09 (0.72)	2.09 (0.71)	2.06 (0.90)	2.48 (0.75)	2.03 (0.78)
HDLC (mmol/l)	1.30 (0.29)	1.40 (0.40)	1.37 (0.45)	1.32 (0.39)	1.37 (0.40)	1.35 (0.38)
HDL_2 (mmol/l)	0.18 (0.15)	0.20 (0.22)	0.19 (0.27)	0.16 (0.19)	0.22 (0.21)	0.19 (0.20)
HDL_3 (mmol/l)	1.12 (0.22)	1.20 (0.30)	1.18 (0.34)	1.16 (0.29)	1.15 (0.26)	1.16 (0.28)
HDLC/TC	0.38 (0.09)	0.36 (0.11)	0.34 (0.11)	0.32 (0.11)	0.31 (0.10)	0.35 (0.10)
Apo-A_1 (µmol/l)	3.86 (0.81)	4.23 (1.14)	4.31 (1.19)	4.27 (1.0)	4.32 (0.84)	4.14 (1.02)
Apo-B (µmol/l)	87.7 (25.7)	108.0 (39.8)	110.0 (34.7)	133.2 (49.0)	152.5 (44.5)	108.0 (41.0)
TAG (mmol/l)	0.94 (0.47)	1.29 (1.19)	1.59 (2.86)	1.96 (1.17)	2.22 (1.58)	1.39 (1.59)
	Women — age groups (yrs)					
	15 - 24 (*N* = 171)	25 - 34 (*N* = 147)	35 - 44 (*N* = 109)	45 - 54 (*N* = 64)	55 - 64 (*N* = 53)	15 - 64 (*N* = 544)
TC (mmol/l)	3.82 (0.98)	4.07 (0.86)	4.35 (0.92)	4.72 (1.02)	5.11 (0.73)	4.15 (0.98)
LDLC (mmol/l)	2.17 (0.92)	2.22 (0.78)	2.43 (0.90)	2.63 (0.83)	2.83 (0.63)	2.31 (0.86)
HDLC (mmol/l)	1.28 (0.30)	1.40 (0.37)	1.42 (0.36)	1.42 (0.31)	1.48 (0.34)	1.37 (0.34)
HDL_2 (mmol/l)	0.17 (0.15)	0.22 (0.22)	0.22 (0.19)	0.19 (0.17)	0.20 (0.13)	0.20 (0.18)
HDL_3 (mmol/l)	1.11 (0.23)	1.17 (0.25)	1.20 (0.27)	1.23 (0.24)	1.28 (0.24)	1.17 (0.25)
HDLC/TC	0.35 (0.09)	0.35 (0.09)	0.34 (0.10)	0.31 (0.08)	0.30 (0.06)	0.34 (0.09)
Apo-A_1 (µmol/l)	3.83 (0.90)	4.19 (0.89)	4.39 (0.93)	4.38 (0.80)	4.74 (0.73)	4.14 (0.91)
Apo-B (µmol/l)	99.2 (33.0)	103.9 (32.2)	111.7 (31.0)	133.6 (42.8)	160.4 (53.3)	109.4 (38.9)
TAG (mmol/l)	0.85 (0.49)	0.99 (0.48)	1.22 (0.72)	1.51 (0.93)	1.94 (1.19)	1.08 (0.74)

Table II. Percentile distribution of TC (mmol/l)

	Men						
Age group	5	10	25	50	75	90	95
15 - 24	2.4	2.6	3.1	3.5	3.9	4.5	4.9
25 - 34	2.8	3.1	3.6	4.0	4.6	5.0	5.3
35 - 44	2.8	3.1	3.5	4.1	4.7	5.2	5.8
45 - 54	2.9	3.1	3.6	4.1	5.1	5.5	5.8
55 - 64	3.1	3.6	4.2	4.6	5.3	5.7	5.9
15 - 64	2.6	2.9	3.4	3.9	4.5	5.2	5.5
	Women						
Age group	5	10	25	50	75	90	95
15 - 24	2.6	2.8	3.3	3.7	4.3	4.8	5.4
25 - 34	2.7	2.9	3.5	4.1	4.6	5.1	5.5
35 - 44	2.9	3.2	3.7	4.3	4.9	5.6	6.0
45 - 54	3.5	3.6	3.9	4.5	5.4	6.0	6.4
55 - 64	3.5	3.9	4.3	5.0	5.8	6.9	7.1
15 - 64	2.8	3.0	3.5	4.1	4.7	5.6	6.1

Table III. Percentile distribution of LDLC

	Men						
Age group	5	10	25	50	75	90	95
15 - 24	0.9	1.1	1.4	1.8	2.2	2.7	3.0
25 - 34	1.0	1.3	1.7	2.1	2.5	3.0	3.4
35 - 44	1.1	1.3	1.6	2.0	2.5	2.9	3.2
45 - 54	0.7	1.0	1.4	2.1	2.6	3.3	3.6
55 - 64	1.1	1.3	1.6	2.6	3.1	3.7	3.8
15 - 64	1.0	1.1	1.5	2.0	2.5	3.0	3.4
	Women						
Age group	5	10	25	50	75	90	95
15 - 24	1.1	1.3	1.7	2.1	2.5	3.1	3.6
25 - 34	0.9	1.2	1.7	2.2	2.7	3.3	3.5
35 - 44	1.1	1.2	1.6	2.4	2.9	3.6	3.9
45 - 54	1.1	1.6	2.1	2.7	3.1	3.5	3.7
55 - 64	1.2	1.7	2.2	2.9	3.3	3.9	4.9
15 - 64	1.1	1.3	1.7	2.3	2.8	3.4	3.7

Table IV. Percentile distribution of HDLC/TC ratio

	Men						
Age group	5	10	25	50	75	90	95
15 - 24	0.23	0.26	0.31	0.37	0.42	0.50	0.54
25 - 34	0.21	0.23	0.28	0.33	0.45	0.50	0.54
35 - 44	0.21	0.24	0.26	0.32	0.42	0.49	0.55
45 - 54	0.18	0.20	0.23	0.29	0.40	0.48	0.52
55 - 64	0.18	0.20	0.22	0.26	0.35	0.49	0.57
15 - 64	0.20	0.22	0.27	0.34	0.42	0.49	0.54
	Women						
Age group	5	10	25	50	75	90	95
15 - 24	0.22	0.25	0.30	0.34	0.39	0.48	0.51
25 - 34	0.22	0.25	0.28	0.35	0.40	0.46	0.49
35 - 44	0.20	0.21	0.27	0.33	0.39	0.47	0.58
45 - 54	0.20	0.21	0.24	0.29	0.37	0.41	0.46
55 - 64	0.18	0.20	0.23	0.27	0.33	0.44	0.51
15 - 64	0.20	0.22	0.27	0.33	0.39	0.46	0.51

women the mean TC concentration increased with age (Table I). The overall mean TC concentration, as well as age-specific TC, was higher for women than men. Prevalence of lipid risk factors for CHD are given in Table V. The risk criteria used were those compiled by an *ad hoc* committee of the Heart Foundation of Southern Africa in 1987.[9] According to these cut-off levels, 15.4% of men and 23.5% of women had TC levels indicating a moderate CHD risk. Men younger than 35 years had a higher prevalence of hypercholesterolaemia than men older than 35 years. This trend was not observed for women. Few participants had a high risk for CHD according to their TC levels.

In both men and women the LDLC concentration increased gradually with age with an overall higher concentration in women than men (Table I). Few men and women exceeded the LDLC cut-off levels, indicating moderate or high risk for CHD.[9]

HDLC (Table I) levels in men fluctuated between 1.30 and 1.40 mmol/l for all the age groups. In women, HDLC concentration showed a small increase from 1.28 to 1.48 mmol/l over the age range studied. Only in the oldest two age groups did women have higher HDLC concentrations than men. When HDLC below 1 mmol/l was used as a cut-off point for increased risk for CHD,[9] 16.2% of men and 15.6% of women were at risk.

HDL_3C was approximately six times higher than HDL_2C levels in both men and women. HDL_2C and HDL_3C showed little variation with age and did not differ between the sexes (Table I). The HDLC/TC ratio showed a gradual decline with age in both sexes, with men showing a steeper decline than women. Only 3.9% of women and 4.0% of men had an HDLC/TC ratio below the cut-off level of 20% usually associated with increased risk for CHD.[9]

Apo-A1 showed an initial increase in young men and plateaued after the age of 35 years; it gradually increased in women throughout the age range, with little difference between the sexes. Apo-B increased markedly with age in both sexes, without any difference between sexes.

Mean plasma TG concentration increased dramatically in both sexes with age, men displaying higher TG concentrations than women in all age groups. Among the men, 12.9% and 5.2% of women had a plasma TG concentration exceeding 2.3 mmol/l (200 mg/dl).

From the questionnaire information, personal awareness of hypercholesterolaemia was extremely low: only 0.4% of men and none of the women reported being hypercholesterolaemic at the time of the study. None of the participants reported having a family member with hypercholesterolaemia.

Discussion

The TC levels in our study were markedly lower in all age groups than those reported in similar studies among other population groups (Fig. 1).[10-12] The TC levels of the BRISK population did, however, show the characteristic rise in cholesterol levels with age in both men and women.[13] Women had higher TC levels than men in each age category, which could possibly be explained by the high prevalence of obesity found among women in our study population. About 50% of women over the age of 35 years were obese (body

Table V. Prevalence (%) of lipid risk factors for CHD

	Age group (men)						Age group (women)					
	15 - 24	25 - 34	35 - 44	45 - 54	55 - 64	15 - 64	15 - 24	25 - 34	35 - 44	45 - 54	55 - 64	15 - 64
TC												
Moderate	15.8	22.6	9.7	11.1	9.7	15.4	25.2	21.8	22.2	24.0	25.3	23.5
High	3.1	0	0.7	0	0	1.1	4.8	0.9	0	1.7	2.0	2.3
HDL												
< 1 mmol/l	16.4	11.8	16.2	26.2	13.9	16.2	17.6	15.8	15.9	11.1	7.8	15.6
HDL/TC	2.5	2.5	2.8	10.5	9.7	4.0	3.3	1.7	5.3	6.2	11.2	3.9
< 20%												
LDL												
High	0.7	0	0	0	0	0.2	1.1	0.9	0	1.6	3.5	1.0
> 4.9 mmol/l												
Moderate	0.7	0	1.0	0	2.3	0.6	1.8	0.9	3.1	3.1	7.3	2.2
> 4.1 mmol/l												
PTG												
4.5 mmol/l	1.6	12.6	11.7	33.2	34.2	12.9	1.8	3.0	5.2	17.6	17.2	5.2

mass index > 30).[7] The fact that almost 25% of women had TC levels above the cut-off level for moderate risk should be a cause for concern. It is clear from the TC percentiles (Table II) that the upper 10% of women over the age of 45 constitutes a potential risk group. Men below 35 years had a higher prevalence of moderate risk than those over 35 years, which may pose a future problem. The low prevalence of high TC risk in both men and women may contribute to the low prevalence of IHD.[9]

In respect of TC, black South African women exhibited a closer association with other population groups than did men. Compared with other local studies, our study showed TC levels lower than those of urban and higher than those of rural black South Africans.[1-4] This could partly be explained by the constitution of our sample. Both so-called new arrivals, mostly from rural areas, and settled inhabitants, who could represent a pool of low and higher TC levels respectively, were included in our study. Alternatively, the BRISK population could be considered to exhibit a transitional TC profile, i.e. a profile that was changing from a rural to an urban one.[6] Compared with studies done among urban indigenous Zimbabwean and Nigerian groups, our study population exhibited lower TC levels. A possible explanation may be a longer exposure to an urban environment by the Zimbabwean and Nigerian groups.[14,15]

The BRISK population showed similar age-related LDLC trends to the coloured population in the CRISIC (coronary risk factors in the coloured population of the Cape Peninsula) study[12] although the LDLC levels were markedly lower, differing by more than 1 mmol/l in most age groups. The low LDLC levels were emphasised when subjected to the CHD risk cut-off points for LDLC.[9] The low LDLC in our study was the most important contributor to the low TC levels observed. The higher TC levels in women could be ascribed to higher LDLC levels than found in men. The proven association between LDLC and IHD could explain why the low LDLC levels in our study were associated with a low prevalence of IHD.[1]

The gender difference in HDLC levels was less pronounced than in white men and women, as was also observed in the American CARDIA (coronary artery risk development in young adults) study.[10,16] Black South African men had higher HDLC levels than their white[10] and Indian counterparts,[11] but lower than those reported for coloureds.[12] Women in the BRISK study had HDLC levels similar to white, higher than Indian, but lower than those of coloured women.[10] The fact that 16% of men and women presented with HDLC levels below 1 mmol/l should be viewed in the light of a low TC level. Few studies among black South Africans have concentrated on lipids other than TC. Two studies, one among migrant and the other among farm labourers, showed higher HDLC levels than our study.[3,4] This could be ascribed to the higher level of habitual physical activity of these workers, whereas the BRISK population comprised mostly sedentary people (80.4% of men and 61.8% of women were physically inactive).

Controversy exists over the importance of HDLC subclasses in IHD. Many studies have shown both HDL_2C and HDL_3C to be of equal importance,[17,18] while others have found HDL_2C to exhibit a stronger inverse relationship to IHD than HDL_3C.[19,20] But the contrary has also been proven.[21,22] Among black South Africans, the percentage cholesterol in HDL_3C remains high and even rises in women with an increase in HDLC. If theories of an inverse relationship between HDL_2C/HDL_3C ratios and IHD hold true, the black population, especially women, is in danger of an IHD epidemic.[23]

The BRISK population had a higher and thus more favourable HDLC/TC ratio than those reported by the other South African studies.[3,10-12] The lower HDLC/TC ratios of women compared with those of men could be explained by their higher TC levels. It should, however, be noted that the ratio for both sexes never dropped below 0.30 which is markedly higher than the 0.20 considered a risk limit. The lower levels of LDLC found in our study could be due to a greater proportion of cholesterol's being carried by HDLC, as was found in black men compared with white men in the UK.[19,24]

Despite their non-fasting state, the BRISK men had lower mean plasma TG levels than the Asian men, except in the oldest age decile. Black women had higher plasma TG concentrations than Asian women from the third age decile. The high prevalence of obesity among black women could be a contributory factor.

No participant in this study indicated having a family member with elevated blood cholesterol levels. This could

be explained by the low TC levels found in the study sample, but could also be a result of a lack of knowledge about hypercholesterolaemia.

Our study population had low TC, LDLC and favourable HDLC/TC ratios, all protective against CHD, which may partially explain the relatively low prevalence of CHD. There were, however, individuals who exceeded the recommended lipid cut-off levels for CHD risk. This, combined with the fact that the population as a whole had a lipid profile showing signs of a possible change towards that of a typical urban population, should be a warning that changes are occurring and that preventive measures should be considered. Suffice to say that our study indicated a transition from a rural toward an urban lipid profile.

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