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Cross-cultural comparison of Lp(a) profiles

ZW Xiong[1] MD, PhD, ML Wahlqvist[1] MD, FRACP, B Biegler†[1] FAIMLS, NDH Balazs[2] BSc, FAACB, P Van Buynder[3] MB BS, DipRACOG, MPH, FAFPHM, W Lukito[4] MD, PhD, B H-H Hsu-Hage[1] MS PhD, N Wattanapenpaiboon[1] MSc(Pharm), PhD and TI Ibiebele[1] MS, PhD

[1]Monash University Department of Medicine, [2]Department of Clinical Biochemistry, Monash Medical Centre, Melbourne, Victoria, Australia
[3]South Eastern Public Health Unit, Goulburn, New South Wales, Australia
[4]SEAMEO-TROPMED Regional Center for Community Nutrition, University of Indonesia, Jakarta, Indonesia

Lipoprotein(a) (Lp(a)) and apolipoprotein(a) (apo(a)) phenotypes as genetic markers for coronary heart disease (CHD) have been the focus of great interest in recent times. Included in this study were four Australian populations comprising 348 Anglo-Celtic Melburnians (157 men and 191 women), 339 Chinese Melburnians (169 men and 170 women), 402 South Asian Melburnians (216 men and 186 women) and 394 Aboriginal Australians from Western Australia (175 men and 219 women). Plasma Lp(a) concentrations were more highly skewed towards the lower range in the Chinese and Aboriginal groups than in the Anglo-Celtics and South Asians. Approximately 33% of Anglo-Celtics, 20% Aboriginals, 13% Chinese and 44% South Asians had plasma Lp(a) levels above the generally accepted risk threshold values of 300 mg/L. In Aboriginals and Chinese, the S4 apo(a) phenotype predominated while in Anglo-Celtics and South Asians, the highest frequency occurred in the S3 phenotype. In the S4 phenotype, Lp(a) values varied between the four populations but there was no significant difference in concentration between gender.

Key words: lipoprotein(a), apolipoprotein(a), zygosity, molecular weight, phenotypes, risk threshold, ethnic groups, independent variables.

Introduction

Since Lp(a) was first described by Professor Kare Berg in 1963, much research has been undertaken to investigate the role of Lp(a) in human physiology and pathology. Although its role has not yet been entirely established, Lp(a) is known to possess thrombotic and atherogenic properties.[1]

Several population-based studies have focused on Lp(a) and have shown that distribution and mean concentrations differ among ethnic populations, with concentrations being several times higher in Africans than in Caucasians.[2–5]

Australia's history is one of immigration. After the Second World War, large numbers of migrants came to Australia from continental Europe and later from Asia. Australia has the second largest overseas born workforce of any country in the world, second only to Israel. Sydney and Melbourne, which have a large percentage of residents born outside Australia, are among the world's most multilingual cities. Australia is therefore an ideal environment for cross-cultural studies.

In order to determine whether differences in Lp(a) are attributable to factors additional to the effects of apo(a) phenotypes, this study is devoted to a comparison of Lp(a) in four ethnic populations of Australian residents.

Subject populations

Four ethnic populations provided the basis for this study, the aim of which was to make cross-cultural comparisons of Lp(a) concentrations and apo(a) phenotypes and to identify factors which might contribute to any differences found.

The four populations investigated were: Anglo-Celtic Melburnians (ACS), Indigenous Australians from Western Australia (PAS), Chinese Melburnians (CHS), and South Asian Melburnians (IHS).

Subjects who fulfilled the entry criteria for the study were randomly selected from each ethnic group. The criteria specified that participants should be apparently healthy male and female individuals, aged 25 or over, born in Australia or with Australian citizenship or permanent resident status. Pregnant and lactating women should not be included. The participation rate should be similar for men and women.

Anglo-Celtic Melburnians

Recruitment was restricted to Australian-born persons of Anglo-Celtic background, namely Irish, Scottish, Welsh and English ancestry. Of the total number of recruits, 348 (157 males, 191 females) underwent Lp(a) measurement and apo(a) phenotype assessment.

Aboriginal Australians from Western Australia

Recruitment of participants of Aboriginal ancestry or descent was from a mixture of Aboriginal communities ranging from small outstations to major rural towns. Of the participants,

Correspondence address: Professor Mark L Wahlqvist, Department of Medicine, Monash Medical Centre, 246 Clayton Road, Clayton, Victoria 3168, Australia
Tel: 613 9550 5525; Fax: 613 9550 5437
Email: mark.walqvist@med.monash.edu.au
†, deceased

175 males and 219 females were assessed for Lp(a) and apo(a) status.

Chinese Melburnians

Recruitment was restricted to persons of Chinese ethnic origin and their descendants born in mainland China, Hong Kong, Malaysia, Singapore and Vietnam, and presently residing in Melbourne. Lp(a) and apo(a) phenotype assessment was carried out on 169 males and 170 females.

South Asian Melburnians

Recruitment was from Melbourne residents of ethnic South Asian ancestry who had migrated to Australia from the Indian subcontinent, Africa, Fiji/Malaysia and Singapore. A representative sample of 216 males and 186 females was assessed for Lp(a) concentration and apo(a) phenotype.

Measurement of Lp(a) concentration

Lp(a) concentrations were measured on the Anglo-Celtic population and the Australian Aboriginals by an in-house immunoturbidimetric assay (ITA) using a COBAS 'FARA' II centrifugal analyser (Roche, Basel, Switzerland). Polyclonal anti-human Lp(a) antisera, standards and controls were from Incstar (Stillwater, MN USA).

Measurements on the South Asian cohort were by an in-house ITA on a KONE Progress Selective Analyser (KONE, Finland) with anti-human Lp(a) antisera from Behring (Behringwerke AG, Marburg, Germany) and Lp(a) standards and controls from Incstar. Prior to the commencement of these analyses, a comparison was made between the results obtained on the KONE and those on the COBAS FARA analysers. Good agreement was shown ($r = 0.98$):

$$Y\ (\text{Kone}) = 1.79 \times (\text{Cobas Fara}) - 20.524$$

Since some of the Chinese samples had undergone prolonged and possibly inadequate storage, it was found that the Lp(a) molecule had broken down into its components, apo(a) and apo B-100. As a result, apo(a) phenotypes could be reliably assessed on the these specimens but Lp(a) concentrations were grossly underestimated. The Kabi Pharmacia RIA, later known as Mercodia, is a solid phase, two site double antibody immunoradiometric assay based on a direct sandwich technique. Because it measures apo(a) rather than Lp(a), it was used for analysis of these samples and Lp(a) concentrations in mg/L were derived from the manufacturer's information that 1 unit of apo(a) is approximately equivalent to 0.7 mg/L of Lp(a).

Early in our study a variety of analytical techniques were used to measure Lp(a) which include radioimmunoassay (RIA), enzyme linked immunosorbent assay (ELISA) immunonephelometry (INA) in both end-point and rate modes and immunoturbidimetry (ITA), again in both end-point and rate modes. All values were adjusted to the common calibrator value to allow direct comparison of results. These results indicated that the ITA assays give good correlation with the RIA reference technique ($r = 0.92$).

For statistical purposes, Lp(a) levels which were below the limit of sensitivity of the assay used, have been recorded as zero. Similarly, when no visible banding pattern was seen on polyacrylamide gel electrophoresis (PAGE), the putative homozygous null phenotype was recorded as 'null'.

A plasma Lp(a) level of 300 mg/L is the generally accepted threshold for increased risk of atherosclerosis, despite the lack of internationally accepted standards or reference methods. Our early study of analytical techniques had shown that the risk threshold for CHD is highly method-dependent. The RIA with a commonly quoted threshold value of 300 mg/L is equivalent to a risk threshold 190 mg/L in the low cost ITA.

Assessment of apo(a) phenotypes

Apo(a) phenotypes were assessed by sodium dodecyl sulphate (SDS) PAGE, using a modification of the method of Huang *et al.*,[6] based on the method of Utermann *et al.*[7] SDS is an anionic detergent which dissociates proteins into their polypeptide subunits and imparts a negative charge to these subunits. Protein denaturation is aided by heating the samples under investigation in buffer containing excess SDS and mercaptoethanol. Under these conditions proteins migrate in PAGE according to their molecular size. A discontinuous gel, consisting of a running (lower) gel and a stacking (upper) gel was used. The stacking gel concentrates large sample volumes, resulting in improved resolution of protein bands.

Data analysis

Data obtained from the studies were entered into a computer database using a DBase III Plus program, then converted into a Statistical Analysis System (SAS)[8] data set. All statistical analyses were performed by using the same SAS software package. A P-value < 0.05 was considered statistically significant. The Lp(a) frequency distribution in all four populations studied, was skewed to low levels which, for statistical purposes is an abnormal distribution, therefore a non-parametric statistical evaluation of the Lp(a) data was obligatory. A descriptive analysis was used to report distribution of samples. The frequency percentage was obtained from SAS procedure PROC FREQ. The mean, median, standard deviation (SD), standard error of mean (SEM), coefficient of variation (CV) and percentile distribution were obtained from SAS procedures PROC MEANS and PROC UNIVARIATE. The SAS procedure PROC ANOVA (analysis of variance) with CLASS variables were used to make inter-population comparisons.

Results

Comparison of Lp(a) concentrations in the four Australian populations

Figures 1a,b show that the frequency distribution of Lp(a) concentrations was skewed toward lower levels in the four ethnic groups, being more highly skewed in the Chinese and Aboriginal groups than in the Anglo-Celtic and South Asian populations. Mean, median and percentiles Lp(a) concentrations are listed in Table 1, in which significantly different mean values occur among the four ethnic groups ($P < 0.0001$) being highest in Indians (324 mg/L) and lowest in Chinese (145 mg/L). The Indian mean Lp(a) concentration was two-fold higher than both the Chinese and Aboriginal populations. The 50th percentile Lp(a) concentration was highest in the South Asian subjects (239 mg/L), followed by the Anglo-Celtics (156 mg/L), with the lowest being 79 mg/L in the Chinese.

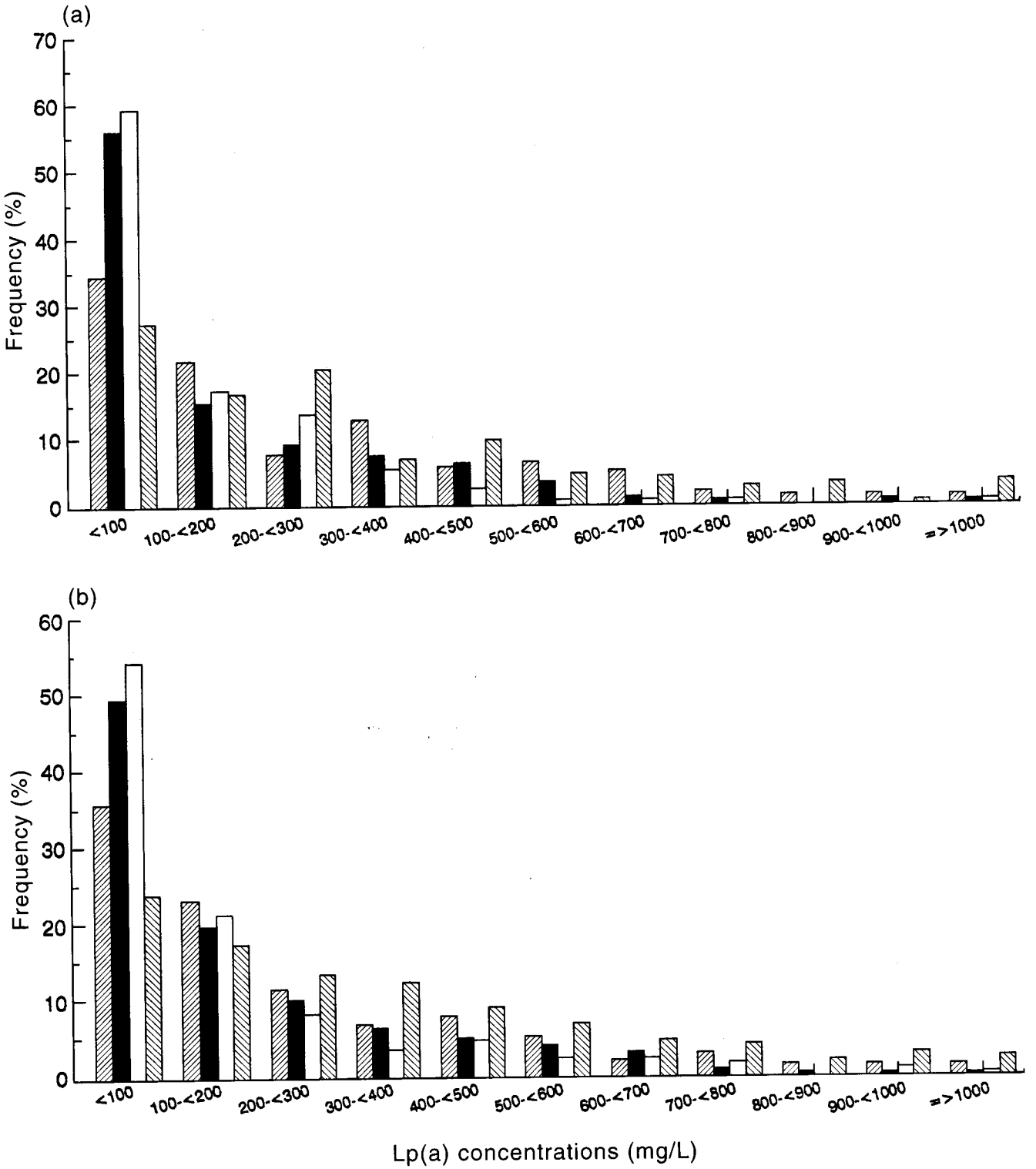

Figure 1. Distribution of Lp(a) levels in (a) men and (b) women. (▨) Anglo-Celtic Melburnians (157 men and 191 women); (■) Indigenous Australians from Western Australia (175 men and 219 women); (□) Chinese Melburnians (169 men and 170 women); (▧) South Asian Melburnians (216 men and 186 women).

The median levels of Lp(a) in the South Asians were three times that found in the Chinese. Table 2 shows that Indians with Lp(a) ≥ 300 mg/L comprise 40.3% of the total number (19.2% male, 21.2% female) whereas the Chinese had the lowest percentage (male 5%, female 8.3%). South Asians also had the highest median Lp(a) (men 520 mg/L, women 527 mg/L) and male Chinese had the lowest (380 mg/L), while in females, Aboriginals had the lowest median Lp(a) levels (446 mg/L). Mean Lp(a) concentration was highest in Indian men and women (629 and 587 mg/L, respectively) and lowest in Aboriginals (men 454 mg/L, women 509 mg/L). Table 3 shows that the percentage of men and women with Lp(a) greater than the method-dependent risk threshold of 190 mg/L, was highest in the South Asian subjects (men 31.3%, women 27.9%) and lowest in the Chinese (men 5%, women 8.3%). Male Anglo-Celtics (432 mg/L) and female

Chinese (504 mg/L) had the highest median Lp(a) levels, while the lowest were seen in the Aboriginals (men 365 mg/L, women 381 mg/L).

Comparison of apo(a) phenotypes in the four populations

Frequency of apo(a) phenotypes in the four ethnic groups is shown in Figs 2a,b, and Table 4. The greatest number of different phenotypes (18 phenotypes) was identified in the South Asian population and the lowest (13 phenotypes) in the Anglo-Celtic population. Phenotypes S1, S2, S3, S4, S1S2, S1S3, S1S4, S2S3, S2S4, S3S4 and 'NULL' occurred frequently in the four populations, while the less common phenotypes F, BS1 and FB3 appeared only in the South Asian population and one FS2 phenotype was identified in an Anglo-Celtic subject. The Anglo-Celtic (24.1%) and South Asian (24.4%) populations had the highest frequency of S3

Table 1. Percentile distribution of Lp(a) concentrations in the four ethnic populations studied

	Lp(a) concentrations (mg/L)									
					Percentiles					
	n	Mean	SD	Min	10	25	50	75	90	Max
Men [a,b]										
Melbourne Anglo-Celtic population study	157	272	292	0	31	70	156	384	658	1972
Australian Aboriginal population from Western Australia study	175	153	174	0	11	29	78	221	413	914
Melbourne Chinese population study	169	124	154	4	7	25	70	165	302	1202
Melbourne South Asian population study	216	310	321	0	24	80	227	426	700	2320
Women [a,b]										
Melbourne Anglo-Celtic population study	191	254	254	0	38	68	156	387	596	1398
Australian Aboriginal population from Western Australia study	219	177	201	0	9	23	102	253	474	1005
Melbourne Chinese population study	170	167	209	4	10	34	86	198	448	1191
Melbourne South Asian population study	186	340	289	0	39	109	282	486	720	1414

[a] *F* value significantly different in four groups: $P < 0.0001$; [b] Wilcoxon rank sum test, 3 d.f.

Table 2. Comparison of elevated Lp(a) concentrations among four populations about the generally accepted risk threshold of 300 mg/L

	Lp(a) concentration ≥ 300 mg/L[c]				
	n	%	Mean	SD	Median
Men [a,b]					
Melbourne Anglo-Celtic population study	57	36.3	568	298	492
Australian Aboriginal population from Western Australia study	34	19.4	454	132	414
Melbourne Chinese population study	17	10.1	464	225	380
Melbourne South Asian population study	77	35.6	629	340	520
Women					
Melbourne Anglo-Celtic population study	57	29.8	580	230	515
Australian Aboriginal population from Western Australia study	46	21.0	509	160	446
Melbourne Chinese population study	28	16.5	569	210	504
Melbourne South Asian population study	85	45.7	587	246	527

[a] *F* value significantly different in four groups: $P < 0.05$; [b] Wilcoxon rank sum test, 3 d.f.; [c] Elevation of Lp(a) was defined as ≥ 300 mg/L.

Table 3. Comparison of elevated Lp(a) concentration among four populations about the method dependent risk threshold

	Lp(a) concentration ≥ risk threshold (mg/L)[c]				
	n	%	Mean	SD	Median
Men [a,b]					
Melbourne Anglo-Celtic population study	69	43.9	510	299	432
Australian Aboriginal population from Western Australia study	51	29.1	384	149	365
Melbourne Chinese population study	17	10.1	464	225	380
Melbourne South Asian population study	126	58.3	477	327	387
Women					
Melbourne Anglo-Celtic population study	80	41.9	482	248	415
Australian Aboriginal population from Western Australia study	71	32.4	417	180	381
Melbourne Chinese population study	28	16.5	569	210	504
Melbourne South Asian population study	112	60.2	506	258	428

[a] *F* value significantly different among four groups: $P < 0.005$; [b] Wilcoxon rank sum test, 3 d.f.; [c] Method-dependent risk threshold for CHS = 300 mg/L, ACS, PAS, IHS = 190 mg/L.

Melbourne Anglo-Celtic population study, Lp(a) assayed by ITA. Risk threshold 190 mg/L. Australian Aboriginal population from Western Australia study, Lp(a) assayed by ITA. Risk threshold 190 mg/L. Melbourne Chinese population study, apo(a) assayed by RIA. Risk threshold 300 mg/L. Melbourne South Asian population study, Lp(a) assayed by ITA. Risk threshold 190 mg/L.

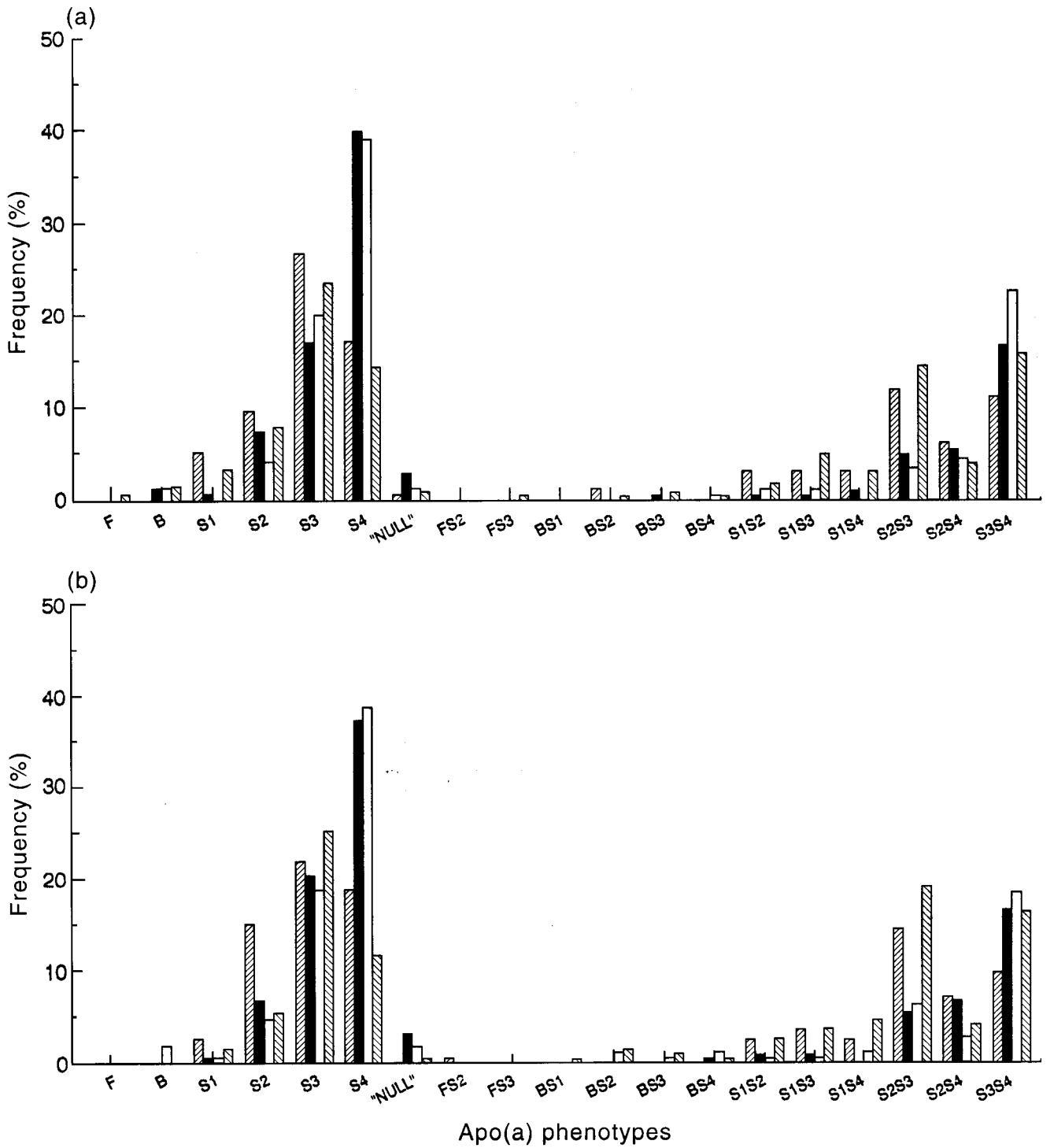

Figure 2. Distribution of Apo(a) phenotypess in (a) men and (b) women. (▨) Anglo-Celtic Melburnians (157 men and 191 women); (■) Indigenous Australians from Western Australia (175 men and 219 women); (□) Chinese Melburnians (169 men and 170 women); (▧) South Asian Melburnians (216 men and 186 women).

phenotypes, while the highest frequency in Aboriginals (38.6%) and Chinese (38.9%) was the S4 phenotype.

Contribution of the apo(a) phenotypes to plasma Lp(a) concentrations

A comparison of mean and median Lp(a) concentrations in apo(a) phenotypes are presented in Tables 5 and 6. Figure 3a,b and Table 7 show that Lp(a) concentrations were obtained for each of the phenotypes categories, with the mean levels being higher in South Asians than in the other three ethnic groups. Lp(a) concentrations in heterozygous phenotypes were higher than in homozygous phenotypes, also Lp(a) levels in small molecular weight phenotypes were higher than in the large in the 50th percentile, in all the populations.

Discussion

Although many studies have been carried out on Lp(a) in various populations,[9,10] to date not much information has emerged on Australians. The present study has provided an opportunity to survey Lp(a) in four ethnic populations of Australian residents. Distribution of plasma Lp(a) was, to varying degrees, skewed towards lower levels in all four pop-

Table 4. Frequency of apo(a) phenotypes in the four ethnic populations

Apo(a) phenotypes	ACS		PAS		CHS		IHS	
	n	%	*n*	%	*n*	%	*n*	%
S1	13	3.74	2	0.51	1	0.29	10	2.49
S2	44	12.64	28	7.11	15	4.42	27	6.72
S3	84	24.14	75	19.04	66	19.47	98	24.38
S4	63	18.10	152	38.57	132	38.94	54	13.43
B	—	—	2	0.51	5	1.47	3	0.75
F	—	—	—	—	—	—	1	0.25
NULL	1	0.29	12	3.05	5	1.47	3	0.75
S1S2	10	2.87	3	0.76	3	0.88	9	2.24
S1S3	12	3.45	3	0.76	3	0.88	18	4.48
S1S4	10	2.87	2	0.51	2	0.59	16	3.98
S2S3	47	13.51	21	5.33	17	5.01	68	16.82
S2S4	24	6.90	25	6.35	13	3.83	17	4.23
S3S4	37	10.63	67	17.01	71	20.94	66	16.42
BS1	—	—	—	—	—	—	1	0.25
BS2	2	0.57	—	—	2	0.59	4	1.00
BS3	—	—	1	0.25	1	0.29	4	1.00
BS4	—	—	1	0.25	3	0.88	2	0.50
FS2	1	0.29	—	—	—	—	—	—
FS3	—	—	—	—	—	—	1	0.25

NULL, Not detectable; ACS, Melbourne Anglo-Celtic population study; PAS, Australian Aboriginal population from Western Australia study; CHS, Melbourne Chinese population study; IHS, Melbourne South Asian population study.

Table 5. Mean Lp(a) concentrations in apo(a) phenotypes in four ethnic populations

	Lp(a) concentrations (mg/L)							
Apo(a) phenotypes	ACS		PAS		CHS		IHS	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
S1	517	175	464	196	651	—	706	296
S2[a]	420	320	349	160	360	103	544	277
S3[b]	162	120	139	168	104	106	199	143
S4[c]	87	75	94	72	57	48	71	63
B	—	—	577	36	193	205	485	63
F	—	—	—	—	—	—	298	—
NULL[a]	0	0	10	5	30	27	0	0
S1S2	540	409	750	292	957	414	940	478
S1S3	438	316	504	189	428	323	464	305
S1S4	603	220	495	21	457	633	453	256
S2S3[b]	270	265	312	182	404	216	488	293
S2S4	402	423	363	218	284	168	423	279
S3S4	180	163	178	173	126	108	176	127
BS1	—	—	—	—	—	—	470	—
BS2	412	291	—	—	771	265	411	214
BS3	—	—	558	—	175	—	942	927
BS4	—	—	354	—	475	239	346	198
FS2	485	—	—	—	—	—	—	—
FS3	—	—	—	—	—	—	784	—

[a] Significantly different between two groups: $P < 0.05$, Wilcoxon rank sum test, 3 d.f.; [b] Significantly different between two groups: $P < 0.0001$, Wilcoxon rank sum test, 3 d.f.; [c] Significantly different between two groups: $P < 0.01$, Wilcoxon rank sum test, 3 d.f.
ACS, Melbourne Anglo-Celtic population study; PAS, Australian Aboriginal population from Western Australia study; CHS, Melbourne Chinese population study; IHS, Melbourne South Asian population study.

ulations, with the Indians' mean and median concentration being, respectively, two and three times higher than those in the other three groups. The lowest mean and median Lp(a) levels were in the Chinese. The results supported our earlier hypothesis that Indians have the highest and Chinese the lowest Lp(a) levels. Previous studies have shown that the distribution of Lp(a) concentrations are skewed to lower levels in white and Asian populations whereas in black people, it tends to be Gaussian. Our hypothesis that the dark-skinned Aboriginal Australians, might have a similar distribution to Africans[1,2,4] and African Americans,[9,10] could not be substantiated since the Aboriginal people showed a very high skew to low levels, in this respect being second only to the Chinese population.

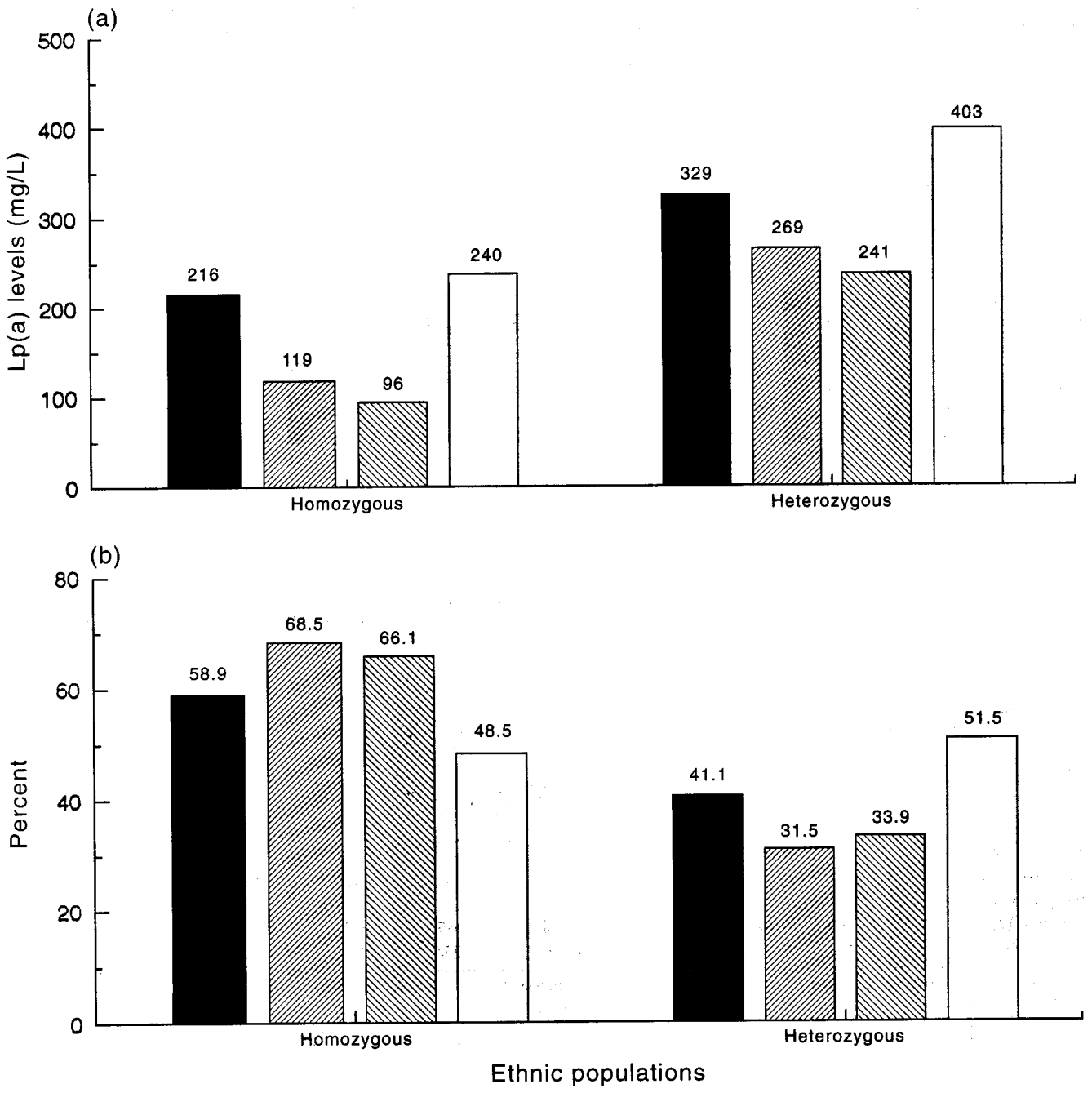

Figure 3. (a) Mean Lp(a) concentrations between homozygous and heterozygous apo(a) phenotypes. (b) Frequency distribution of homozygous and heterozygous apo(a) phenotypes. (■) 348 Anglo-Celtic Melburnians; (▨) 394 Indigenous Australians from Western Australia; (▧) 339 Chinese Melburnians; (□) 402 South Asian Melburnians.

Numerous studies have shown an association between the plasma Lp(a) and the incidence of CHD in the general population,[11–14] wherein the risk threshold for developing CHD was set at 300 mg/L,[15–17] despite various methodology and a lack of international standardization.[18] In order to enhance the validity of comparisons of Lp(a) between our representative Australian white, black and Asian populations, a study of analytical techniques for measuring Lp(a) was carried out. This study confirms and stresses that the generally accepted cut off point of 300 mg/L cannot be used as a threshold regardless of methodology and emphasizes the necessity to derive threshold values for each method used. In the comparison of Lp(a) concentrations among the four populations, both the generally accepted risk threshold and the method-dependent risk threshold values were used. Whether subjects had Lp(a) levels greater than 300 mg/L or greater than the method-dependent threshold, mean Lp(a) levels were different among the four populations. The Melbourne Indians with Lp(a) greater than 300 mg/L (40.3%) and the method-dependent threshold of 190 mg/L (59.2%) had the highest frequency while the Chinese had the lowest (Tables 2 and 3).

The results imply that migrants to Australia from the Indian subcontinent are at greatest risk for developing CHD, although plasma Lp(a) might not be such a strong risk factor for CHD in this dark-skinned people, based on the limited data available to date.[19–21] Australians of ethnic Chinese origin were at lowest risk.

Table 6. Median Lp(a) concentrations in apo(a) phenotypes in four ethnic populations

	Lp(a) concentrations (mg/L)											
	ACS			PAS			CHS			IHS		
Apo(a)	Min	Med	Max	Min	Med	Max	Min	Med	Max	Min	Med	Max
S1	186	532	788	325	464	602	651	651	651	364	640	1292
S2	11	390	1398	26	376	670	198	372	559	78	539	1526
S3	10	126	596	0	97	1005	5	73	595	0	178	811
S4	5	67	387	0	41	468	4	48	228	0	56	293
B	—	—	—	551	577	602	8	147	485	428	474	552
F	—	—	—	—	—	—	—	—	—	298	298	298
NULL	0	0	0	0	9	18	4	22	74	0	0	0
SIS2	16	470	1104	526	809	916	479	1191	1202	64	940	1688
SIS3	117	430	1112	340	462	711	210	276	799	39	353	1016
SIS4	256	563	996	480	495	509	9	457	904	99	427	978
S2S3	26	173	1398	19	327	694	116	391	716	24	422	1365
S2S4	23	278	1973	30	391	745	19	272	700	12	480	972
S3S4	10	130	744	0	131	914	4	97	517	0	164	571
BSI	—	—	—	—	—	—	—	—	—	470	470	470
BS2	206	412	617	—	—	—	583	771	958	194	373	703
BS3	—	—	—	558	558	558	175	175	175	342	554	2320
BS4	—	—	—	354	354	354	307	369	748	206	346	486
FS2	485	485	485	—	—	—	—	—	—	—	—	—
FB3	—	—	—	—	—	—	—	—	—	784	784	784

NULL, Not detectable; ACS, Melbourne Anglo-Celtic population study; PAS, Australian Aboriginal population from Western Australia study; CHS, Melbourne Chinese population study; IHS, Melbourne South Asian population study.

Table 7. Association of mean Lp(a) concentrations with zygosity and molecular weight of apo(a) phenotypes in four ethnic populations

	Lp(a) concentrations (mg/L)								
Apo(a)	ACS		PAS		CHS		IHS		
phenotypes	*n*	Mean	*n*	Mean	*n*	Mean	*n*	Mean	*P*[b]
Zygosity									
Homozygous	205	216	270	119	224	97	195	240	[a]
Heterozygous	143	329	124	269	115	241	207	403	[a]
Molecular weight									
Small MWt	163	402	89	374	65	397	182	524	[a]
Large MWt	185	139	305	106	274	86	220	159	[a]

[a] Significantly different between four groups: $P < 0.0001$. [b] Wilcoxon rank sum test, 3 d.f.
Homozygous, single band phenotypes F, B, Sl, S2, S3, S4, and NULL; Heterozygous, double band phenotypes SIS2, SIS3 etc.; Large MWt, apo(a) phenotypes S3, S4, S3S4, and NULL; Small MWt, all other apo(a) phenotypes; ACS, Melbourne Anglo-Celtic population study; PAS, Australian Aboriginal population from Western Australia study; CHS, Melbourne Chinese population study; IHS, Melbourne South Asian population study.

In order to compare the prevalence of elevated Lp(a) concentrations greater than 300 mg/L in various apo(a) phenotypes, and mean Lp(a) concentrations among subjects who have the same phenotypes, a reanalysis of this data based on large and small molecular weight phenotypes was carried out. The small molecular weight phenotype was the predominant one when Lp(a) concentrations are greater than 300 mg/L. The distribution of Lp(a) concentrations above 300 mg/L was greatest in the Anglo-Celtics and lowest in Chinese, but the highest risk for developing CHD was in the Indian cohort (data not shown). Of the four ethnic populations, the Indians also had the highest prevalence of elevated Lp(a) (i.e. 300 mg/L) among those with large molecular phenotypes.

Although evaluation of the effects of zygosity of apo(a) phenotypes on Lp(a) levels is less tenable in the absence of family data, in this study homozygous phenotypes were associated with lower Lp(a) concentrations than the heterozygous in all four ethnic groups; these results are compatible with previously published data.[22–25]

We found a similar trend of a higher prevalence of heterozygous and small molecular weight phenotypes in the Indian population than in the other three groups. The results again suggested that the Indian population is at greatest risk of CHD development.

The major apo(a) phenotypes occurred in all four racial groups. In the Aboriginals and Chinese, the S4 phenotype predominated while in the Anglo-Celtics and Indians, the S3 was the most frequently occurring. In the S4 phenotype, Lp(a) concentrations fluctuated from 5 to 387 mg/L in the Anglo-Celtics, 0 to 468 mg/L in the Aboriginals, 4 to 228 mg/L in Chinese and from 1 to 293 mg/L in Indians. These observations further support ethnic differences in the distribution of apo(a) and associated Lp(a) levels, and demonstrate that genetic factor is not the only influence to decide variation of Lp(a) concentrations.

Conclusions
Lp(a) concentrations are distributed in each percentile, the percentages of medium in four ethnicity, the highest for Indians, then for Anglo-Celtics, then for Aboriginals and the lowest for Chinese. Based on the distribution of Lp(a) levels in the four populations studied, Indian immigrants are at the highest risk for developing CHD, while Chinese have the lowest risk. The apo(a) phenotype clearly influences Lp(a) levels but is not only factor to decide variation in Lp(a) concentrations.

Cross-cultural comparison of Lp(a) profiles

ZW Xiong, ML Wahlqvist, B Biegler, NDH Balazs, P Van Buynder, W Lukito, BH-H Hsu-Hage, N Wattanapenpoon and TI Ibiebele

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脂蛋白(a)跨文化比較

摘要

脂蛋白(a)和載脂蛋白(a)表形是冠心病的遺傳標記. 它們一直是近年來人們研究興趣的焦點. 此文包括我們對在墨爾苯生活的(三組不同種族人群和生活在西澳的土著人之間的比較研究. 他們是348名華裔〔其中157名男性, 191名女性〕, 402名印度裔〔其中216名男性, 186名女性〕和394土著澳洲人〔其中175名男性, 219名女性〕.

血漿脂蛋白(a)濃度在華裔與澳洲土著人組中比在英國凱爾特裔和印度裔組中顯著的偏低. 大約33%的英國凱爾特裔, 20%的澳洲土著人, 13%的華裔和44%的印度裔血漿脂蛋白(a)濃度超過一般能接收的危險臨界值300mg/L, 在澳洲土著人和華裔組中, S4載脂蛋白(a)表形最顯著, 而在英國凱爾特裔和印度裔組中, 則是S3表形產生最高的頻率. 在S4表形中, 脂蛋白(a)的濃度在四種族人群之間各不相同, 但其濃度在性別之間没有顯著性差別.

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