Reference Ranges for Serum Total Cholesterol, HDL-Cholesterol, LDL-Cholesterol, and VLDL-Cholesterol and Triglycerides in Healthy Iranian Ahvaz Population

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Abstract Cardiovascular diseases (CVD) are recognized as major mortality causes and imposes tremendously heavy socio-economic burden worldwide. A vast variety of risk factors have been introduced in the literature known to enhance the incidence of CVD, such as hyperlipidemia. Therefore in order to make an accurate clinical decision it is essential to have appropriate reference ranges for lipids and lipoprotein particles in a particular population. Healthy female ($n = 601$) and male ($n = 617$) cases were randomly selected according to certain exclusion criteria from individuals visiting the major University hospital clinics situated in different part of Ahvaz city, Iran, from June 2010 to December 2010. Fasting blood samples (10 ml) were collected and analyzed for total cholesterol, total triglyceride and HDL-C employing enzymatic assays of CHOD-PAP, GPO-PAP and homogenous methods respectively. The samples were obtained such to include the ethnic populations of Persian, Arab. Lore leaving in this city. The data were analyzed statistically by SPSS-18 software. The obtained results were analyzed then age ethnic-wise and reference ranges (mean $\pm$ 1SD) were calculated. Remarkable differences between the obtained results for our population with other nations were seen. Also ethnic difference for HDL-C among our cases was noted. The observed significant differences among different nations and ethnicities emphasizes the need for nation-

specific, local reference ranges for lipids and lipoproteins particles, to be established.

Keywords Atherosclerosis · Ethnicity · Gender · Reference range

Introduction

Atherosclerotic coronary artery diseases affect both men and women and account for >4.5 million deaths annually in developing countries [1]. The incidence of such diseases is reported to increases with advancing age over 40 years in male but lower age implicated in this respect as well [2–5].

There are reports contributing the different global burden of vascular diseases in different population to the ethnic and regional variations in cardiovascular risk factors [6–9]. The above-mentioned facts prompted several investigators to conduct studies on types and distribution modes of traditional and newly recognized risk factors in different populations [10, 11] including lipid and lipoproteins indices [12]. These information provided us with a logically acceptable background to embark on a project to clarifying the distribution pattern of lipids and lipoproteins serum concentrations in male and female groups with different age intervals among the three main ethnic populations living in Ahvaz city situated in southern part of Iran.

Materials and Methods

Asymptomatic healthy subjects women ($n = 601$) and male ($n = 617$) from different ethnicities Lore, Arab and Persian within three age categories 1–15, 16–55 and >55 years were

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Table 1 Exclusion Criteria

Remarkable changes in dietary habits
Non-Fasting state
History indicative of thyroid dysfunction.
History of renal, cardiovascular and liver disease, diabetes mellitus, hypo-hyperthyroidism and any chronic disease.
Smoking, alcohol, drugs affecting lipid concentration, hormone therapy and oral contraceptives.
History of recent myocardial infarction or major surgery.

selected randomly from individuals visiting the major university hospital clinics in different part of the city according to exclusion criteria presented in Table 1 from June 2010 to December 2010. Fasting blood samples of 10 ml were drawn, serum was separated and analyzed for total cholesterol, total triglyceride and HDL-C employing enzymatic CHDD-PAP, GPD-PAP assays and homogenous method respectively. Alcyon auto analyzer, Abbott, USA was employed. Employing Friedwald et al. equation, serum concentrations for LDL-C and VLDL-C were calculated. Reference intervals (Mean $\pm$ 1SD) and mean comparison were determined (Table 2, 3, 4, 5 and 6).

Statistical analyses were done using SPSS-18 software. Independent-sample *t* test and one-way ANOVA used for comparative study. Significant difference estimated at *p* value < 0.05.

Results and Discussion

The distribution characteristics for the studied populations are summarized in Table 2. The over-all mean cholesterol for all ages was 175.3 mg/dl for female and 177.07 mg/dl for male groups respectively the confidence limits (Mean $\pm$ 1SD) were also presented in Table 3. Although

Table 3 Over-all lipids and lipoproteins serum concentration ranges (mean $\pm$ 1SD) for the studied healthy Iranian population

Analyte	Female (mg/dl) (<i>n</i> = 601)	Male (mg/dl) (<i>n</i> = 617)	<i>p</i> Value
T. Cholesterol	175.3 $\pm$ 37.07	177.07 $\pm$ 42.48	0.43
LDL-C	107.11 $\pm$ 33.52	111.48 $\pm$ 32.8	0.022
VLDL-C	21.82 $\pm$ 10.29	25.24 $\pm$ 8.72	0.0001
HDL-C	46.37 $\pm$ 11.91	38.13 $\pm$ 9.45	0.0001
Triglyceride	108.95 $\pm$ 51.81	127.58 $\pm$ 54.97	0.0001

decade-wise analysis of serum cholesterol showed an upward trend in both male and female populations (Fig 1) (Table 4) which seems to be more prominent in female in the third age intervals (>55 years) than in male group although it was not significant (Table 4). Ethnic-based studies showed that Lore ethnic group has the highest serum cholesterol level than other groups with no significant difference between male and females in this respect. In both Arab and Persian groups higher cholesterol serum concentrations were detected in male than in female gender (Table 5). More or less the same trend of changes was observed for LDL-C serum concentration as was seen for total cholesterol.

The estimated values for HDL-C are shown in Table 4. While age-wise trend in male group showed a slight decline in the third age interval, noticeable decrease in HDL-C serum concentration is apparent in female group in age level over 55 years (Fig 2). Values for total triglyceride serum concentrations are shown in Table 3. A higher mean value in male group compared to female group is seen with an increasing trend visible for both sexes with advancing age (Fig 1). In all ethnics groups triglyceride serum concentrations showed significantly higher level in male compared to female groups (Table 5).

Table 2 Distribution characteristics for the studied population

Sex	Male (years)				Female (years)			
		1–15	16–55	>55		1–15	16–55	>55
Sample size	617	179	366	72	601	79	460	62
Average	38.311	38.502	38.407	37.347	46.376	40.730	47.622	44.209
Standard deviation	9.575	10.182	9.294	9.507	12.171	12.531	11.790	12.384
Standard error	0.385	0.761	0.485	1.112	0.496	1.403	0.549	1.572
Minimum	16	21	20	16	15	16	15	24
Maximum	64	60	64	60	92	85	92	79
Range	48	39	44	44	77	69	77	55
Median	38	38	38	35	–	–	–	–
Mode	38	42	38	35	–	–	–	–
Distribution fitting	(N)	(N)	(N)	(N)	(N)	(N)	(N)	(N)

N Normal

Table 4 Age and sex-wise lipid and lipoproteins serum concentration (mg/dl) in the studied healthy groups ($\bar{x} \pm 1SD$)

Analyte (mg/dl)	1–15 years (<i>n</i> = 179) Female 15–55 years (<i>n</i> = 336) >55 years (<i>n</i> = 72)	1–15 years (<i>n</i> = 79) male 15–55 years (<i>n</i> = 460) >55 years (<i>n</i> = 62)	<i>p</i> Value
Total cholesterol	153.3 $\pm$ 31.15	165.22 $\pm$ 35.3	0.01
	175.8 $\pm$ 22.45	178.76 $\pm$ 27.3	0.09
	199.5 $\pm$ 21.5	185.55 $\pm$ 34.8	0.007
LDL-C	93.6 $\pm$ 26.75	104.87 $\pm$ 33.25	0.008
	107.0 $\pm$ 33.0	112.53 $\pm$ 31.6	0.017
	125.5 $\pm$ 44.15	122.81 $\pm$ 35.7	0.69
VLDL-C	18.9 $\pm$ 8.1	22.43 $\pm$ 4.65	0.003
	21.3 $\pm$ 9.8	25.92 $\pm$ 8.75	0.000001
	29.4 $\pm$ 13.1	28.8 $\pm$ 10	0.52
HDL-C	40.65 $\pm$ 12.5	38.62 $\pm$ 10.25	0.00001
	47.65 $\pm$ 11.8	38.34 $\pm$ 9.25	0.000001
	44.21 $\pm$ 12.35	37.34 $\pm$ 9.5	0.76
Total triglyceride	94.94 $\pm$ 41.3	111.68 $\pm$ 42.50	0.17
	106 $\pm$ 48.75	132.6 $\pm$ 63	0.000001
	148.32 $\pm$ 65.15	142 $\pm$ 48	0.0003
Total cholesterol/HDL-C ratio	4.04 $\pm$ 1.35	4.77 $\pm$ 1.3	0.00005
	3.91 $\pm$ 1.35	4.74 $\pm$ 1.3	0.000001
	4.99 $\pm$ 1.55	5.04 $\pm$ 1.64	0.85
LDL-C/HDL-C ratio	2.54 $\pm$ 1.22	3.06 $\pm$ 1.23	0.001
	2.43 $\pm$ 1.13	3.3 $\pm$ 1.25	0.000001
	3.05 $\pm$ 1.35	3.67 $\pm$ 1.5	0.013

LDL-C Low density lipoprotein;
VLDL-C Very low density
lipoprotein; *HDL-C* High
density lipoprotein

Table 5 Ethnic-wise lipids and lipoproteins serum concentration (mg/dl) in the studied healthy groups (Mean $\pm$ 1SD)

Analyte		L (128) Female A (231) P (242)		L (80) Male A (227) P (310)	<i>p</i> Value
Total cholesterol	<i>p</i> > 0.24	178.94 $\pm$ 34.5	<i>p</i> > 0.61	178.44 $\pm$ 34	0.91
		174.15 $\pm$ 38.5		178.17 $\pm$ 55	0.36
		174.49 $\pm$ 37		175.93 $\pm$ 33.5	0.63
LDL-C	<i>p</i> > 0.244	109.95 $\pm$ 31.5	<i>p</i> > 0.21	114.26 $\pm$ 30	0.32
		105.6 $\pm$ 35.05		108.87 $\pm$ 34	0.31
		107.05 $\pm$ 33		112.69 $\pm$ 33	0.046
VLDL-C	<i>p</i> > 0.18	22.46 $\pm$ 10.25	<i>p</i> > 0.59	23.7 $\pm$ 5.8	0.81
		22.39 $\pm$ 10.1		25.42 $\pm$ 9.5	0.001
		20.96 $\pm$ 10.5		25.52 $\pm$ 8.75	0.00001
Hdl-C	<i>p</i> > 0.53	46.65 $\pm$ 11.5	<i>p</i> > 0.01	40.76 $\pm$ 9	0.00001
		45.89 $\pm$ 12.5		37.48 $\pm$ 9.4	0.00001
		46.69 $\pm$ 12		38.29 $\pm$ 9.60	0.00001
Total triglyceride	<i>p</i> > 0.23	111.77 $\pm$ 51	<i>p</i> > 0.51	130.64 $\pm$ 100	0.07
		111.71 $\pm$ 51.25		127.34 $\pm$ 48	0.0008
		105.27 $\pm$ 52.5		126.97 $\pm$ 42	0.00001
Total cholesterol/HDL-C ratio	<i>p</i> > 0.5	4.08 $\pm$ 1.38	<i>p</i> > 0.01	4.49 $\pm$ 1.15	0.027
		4.03 $\pm$ 1.39		4.92 $\pm$ 1.5	0.00001
		3.98 $\pm$ 1.34		4.77 $\pm$ 1.4	0.00001
LDL-C/HDL-C ratio	<i>p</i> = 0.001	2.56 $\pm$ 1.15	<i>p</i> > 0.23	3.11 $\pm$ 1.9	0.009
		3.5 $\pm$ 1.25		3.27 $\pm$ 1.25	0.049
		2.49 $\pm$ 1.14		3.33 $\pm$ 1.35	0.00001

L Lore ethnicity; *A* Arab
ethnicity; *P* Persian ethnicity

Table 6 Mean lipids and lipoproteins concentrations in different populations compared with the studied Iranian population (mg/dl)

Compared populations	<i>n</i>	Total cholesterol	<i>p</i> Value	HDL-C	<i>p</i> Value	Triglyceride	<i>p</i> Value
Men							
All races (20–74 years) Fulwood et.al [14]	5604	221 ± 1.2	0.00001	45.2 ± 0.4 (n = 4562)	0.00001	145 ± 2.9 (n = 1269)	0.00001
Noma et.al [15]	677	184 ± 24	0.0002	52.6 ± 12.6	0.00001	95 ± 27	0.00001
Malati and Mahesh [13]	1161	175.1 ± 34.8	0.29	41.9 ± 9.8	0.00001	139.9 ± 63.5	0.00004
Li et.al [16]	8572	180.1	0.07	49.03	0.00001	148.2	0.00001
Present study	617	177.07 ± 42.42	–	38.13 ± 9.45	–	127.58 ± 54.97	–
Women							
All races (20–74 years) Fulwood et.al. [14]	6260	215 ± 1.2	0.00001	53.7 ± 6.4 (n = 5235)	0.00001	124 ± 2.3 (n = 1111)	0.00001
Noma et.al [15]	467	183 ± 24	0.00001	59 ± 11.5	0.00001	83 ± 26	0.00001
Malati and Mahesh [13]	762	175.4 ± 34.3	0.95	47.2 ± 10.4	0.17	120 ± 54.8	0.00016
Li et.al [16]	6391	183.25	0.00001	57.99	0.00001	118.125	0.00027
Present study	601	175.3 ± 37.07	–	46.37 ± 11.9	–	108.95 ± 51.8	–

Similar cascade of changes are observed for VLDL-C to those seen for total triglyceride concentrations in different ethnics and age groups (Tables 4, and 5). The results of statistical comparative analysis between the obtained values in this study with similar values reported for different populations are summarized in Table 6.

The contribution of various traditional and new risk factors is implicated in different reports [10] and [11]. Derangements in lipids and lipoproteins metabolism known to play a determining role in cardiovascular diseases [12]. Regional and ethnic variations [9] in lipids and lipoproteins serum concentrations necessitate a thorough local investigation in order to determine their relevant reference ranges for a particular population. Although the age and sex-wise distribution patterns for different analytes concentrations obtained in our project showed similar features to that published by other literatures [13] but a noticeable ethnic difference concerning HDL-C values was detected ($p < 0.001$) (Table 5). Comparative analysis between our data with other nations (Table 6) showed that in our male group, the total cholesterol level was lower than that reported for American [14] and Japanese [15] ($p < 0.0001$) with no significant difference with Chinese [16] and Indian [13] values (Table 6). Values obtained for total triglyceride in our trial for male group was lower than the American, Indian and Chinese populations ($p < 0.001$) and higher than that reported for Japanese populations ($p < 0.001$). Our values for HDL-C was lower than figures reported for other nations ($p < 0.0001$).

For female group, total cholesterol level was lower than the American, Japanese and Chinese populations ($p < 0.001$) (Table 6) with no difference with the Indian value ($p = 0.95$). The estimated value for total triglyceride in female group in our experiment was also lower than the values reported for American, Indian and Chinese ($p < 0.001$) and higher than the reported values for Japanese population ($p < 0.001$).

Serum level for HDL-C in our female cases was lower than the same figures reported for other nations ($p < 0.001$) with the exception of the Indian group ($p = 0.17$).

In conclusion our results clearly showed a significant disparity between the obtained results for our studied populations and the indices reported for other nations (Table 6). Also it is worth-reporting that an ethnic difference was detected concerning HDL-C in our populations ($p < 0.01$) (Table 5). These facts emphasizes the need for an epidemiological national survey taking into consideration the effects of variable such as age, sex and ethnicity in order to establish accurate reference ranges for lipids and lipoproteins particles to enable the clinicians to make appropriate clinical decisions.

Fig. 1 Ethnic-wise (a) and age-wise (b) differences for lipids serum concentrations in the studied populations

Fig. 2 Ethnic-wise (a) and age-wise (b) changes of serum concentrations for lipoproteins particles in the studied populations

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