DOI: 10.7860/JCDR/2015/15334.6787

Original Article

Internal Medicine Section

Variation in Lipid Profile Across Different Patterns of Obesity – Observations from Guwahati, Assam

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ABSTRACT

Background: Obesity adversely affects cardiovascular health is known. But, data is few in this regard from Assam, northeast India. The serum lipid profile is performed for cardio-metabolic status assessment.

Aim: The aim of the study was to investigate variation in serum lipids across different obesity patterns in an urban population from Assam.

Materials and Methods: Two hundred subjects were classified by WC (waist circumference) and BMI (body mass index) values into four groups as follows: Group I (normal WC, normal BMI), Group II (normal WC, increased BMI), Group III (increased WC, normal BMI) and Group IV (increased WC, increased BMI). WC and BMI served as measures of central and generalized obesity respectively. Lipid profile was measured using VITROS 5600 Autoanalyser, and compared across these groups. Multivariate analyses were performed separately for males and females to confirm the results of univariate analyses.

Results: WC and BMI exhibited significant correlations with different lipid parameters. Group IV individuals had the most abnormal lipid profile values, while, Group I individuals had the most normal values. Group II and Group III individuals had intermediate values. BMI was independently associated with serum triglycerides in both males and females. WC was independently associated with high density lipoprotein cholesterol in females.

Conclusion: The lipid values varied significantly across different obesity patterns. Serum lipid concentrations were strongly influenced by anthropometric indices of obesity in both sexes. Presence of both central and generalized obesity led to greater abnormalities in lipid profile than presence of central or generalized obesity alone.

Keywords: Anthropometry, BMI, Dyslipidemia, Waist circumference

INTRODUCTION

The serum lipid profile is a test panel carried out to assess the quantitative deviation of various lipid and lipoprotein traits across a biochemical threshold in the serum or plasma. Abnormalities in the lipid profile or dyslipidemia, may manifest as one or more of the following: increased total cholesterol (TC), increased triglycerides (TGL), increased low density lipoprotein cholesterol (LDL-C) or decreased high density lipoprotein cholesterol (HDL-C) [1]. Dyslipidemia is a major risk factor as well as a causal factor for cardiovascular diseases (most notably, coronary artery disease and stroke) [2].

Obesity is a condition of excessive fat deposition in the body to an extent that adversely affects health [3]. Studies have shown that obesity adversely alters the lipid profile which in turn poorly reflects on the cardiovascular health [4-6]. The burden of obesity has assumed pandemic proportions worldwide, with estimates of deaths due to overweight and obesity being 2.8 million each year [7]. Once considered to be a malady of affluent nations, obesity now plagues developing countries like India, too. The prevalence of obesity in India can be as high as 50% in certain groups [8]. Some studies have reported the variation in lipid profile in relation to obesity in certain Indian populations [9]. But, there is a dearth of data from northeast India – a region that is geographically peculiar and ethnically distinct from the rest of the country.

The northeastern region of India is sandwiched between two major subcontinental regions – the Indian subcontinent to the west and the East/Southeast Asia region to the east. It represents a sort of ethnological transition zone between India and neighbouring China, Myanmar and Thailand [10]. Assam is the most populous and second largest (in terms of land area) of the eight north-eastern states. Guwahati, capital city, is the biggest in the region. By and large, the present day population of Assam has an obvious affinity to the other Indian populations, but with discernible Mongoloid elements [11]. We describe the influence of two anthropometric indices of obesity namely, waist circumference (WC) and body mass index (BMI) on serum lipid concentrations in a cross-sectional sample from Guwahati, Assam. Besides, unlike some other studies which carried out correlational analysis between obesity indices and lipid levels, we explored the alteration in serum lipid levels across different patterns of obesity.

MATERIALS AND METHODS

Participants

The participants were recruited from individuals attending out-patient departments of Gauhati Medical College and Hospital (GMCH). A careful screening was done by taking a thorough history, clinical examination and investigation reports. A total of 573 individuals were screened by convenience sampling from September 2013 to January 2014. Individuals with cancer, thyroid disease, diabetes mellitus, pregnancy, liver disease and those on medications that modify lipid profile (like beta-blockers, oral contraceptives, statins, steroids, etc) were excluded from the study to eliminate confounding effects on lipid profile. Two hundred subjects were selected in this manner. The selected individuals belonged to different localities of Guwahati, Assam and identified themselves as natives of the state, with no history of migration from elsewhere at least in the past four generations.

It deserves mention that many people attend GMCH as the chief source of subsidized medical care. Moreover, GMCH is a facility where individuals from various private companies as well as government departments undergo routine health check-up. Therefore although GMCH is a tertiary care referral centre, yet the beneficiaries do not represent a highly selected group with the most severe ailments; but they reflect the general population at large.

The subjects were stratified into four groups depending upon their WC and BMI values as follows: Group I (normal WC, normal BMI), Group II (normal WC, increased BMI), Group III (increased WC, normal BMI) and Group IV (increased WC, increased BMI). The cut-offs for normal and increased WC were used as per the International Diabetic Federation recommendations for South Asians (WC $\geq$ 80 cm in females and WC $\geq$ 90 cm in males was considered as increased WC, and less than that as normal) [12]. For BMI, revised values for Asians as proposed by World Health Organisation were used (BMI $\geq$ 23 kg/m^2 was considered as increased BMI, and less than that as normal) [13].

Anthropometric measurements

Waist circumference (WC) and body mass index (BMI) were used as indices of obesity in this study as estimates of central (or visceral) and general obesity, respectively. Measurement of WC and BMI was carried out as per WHO protocol [14].

Biochemical estimations

The biochemical parameters estimated under lipid profile were TC, TGL, HDL-C and LDL-C. Blood was collected from the medial cubital vein after 12-14 hours of overnight fast and the serum subsequently separated. The concentrations of TC, TGL and HDL-C in the serum were measured photometrically in VITROS 5600 Autoanalyser by enzymatic methods using dry chemistry reagent slides (VITROS Chemistry Products, Ortho-Clinical Diagnostics Inc. USA). LDL-C was estimated indirectly using Friedewald's equation [15]. Rigorous quality control measures were undertaken to ensure accuracy and precision of the test results by using third party control materials (Bio-Rad and Christian Medical College Vellore). The normal level of serum lipids was defined using National Cholesterol Education Programme Adult Treatment Protocol III (NCEP ATP III) guidelines as follows: TC < 200 mg/dL, TGL < 150 mg/dL, LDL-C < 130 mg/dL and HDL-C $\geq$ 40 mg/dL [16].

ETHICS

The guidelines of ethical standards prescribed by the Declaration of Helsinki were followed. Ethical clearance was sought from the Institutional Ethics Committee. All the subjects voluntarily provided informed written consent to participate in the study prior to enrolment.

STATISTICAL ANALYSIS

The data was analysed using SPSS 11.5 software package (SPSS Inc., Chicago, USA). The Kolmogorov-Smirnov test was performed to ensure normal distribution of the data. Pearson's correlation co-efficient (r) was calculated between the anthropometric indices of obesity and serum lipid parameters. Comparison of the lipid parameters amongst the four groups was carried out by using one-way analysis of variance (ANOVA). When significantly different, the variation across the four groups was further assessed by post-hoc critical difference analysis using Tukey-Kramer multiple comparisons test.

Multivariate analyses were performed to confirm the univariate results using regression models. TC, TGL, LDL-C and HDL-C were used as the dependent (outcome) variables. Multiple linear regressions were performed separately for each of these lipid parameters by treating age, BMI and WC as the predictor (independent) variables to assess the individual and combined contribution of these factors towards influencing lipid profile. The analyses were done separately in males and females to account for the role of gender in modulating the influence of BMI and WC on lipid profile.

A p-value of less than 0.05 was considered statistically significant, whereas a p-value of less than 0.01 was considered highly significant.

RESULTS

The ages of the study subjects ranged from 20 to 65 years. Of the 200 subjects, 127 (63.5 %) were male and 73 (36.5 %) female. The lipid profile values and the anthropometric indices of obesity between the male and the female subjects were comparable and so was the age distribution [Table/Fig-1]. None of these parameters differed significantly in a gender-wise manner (p>0.05). Among them, 34.5% had centralised obesity (increased WC) and 53% were generally obese/overweight (increased BMI). The frequencies of abnormal TC, TGL, LDL-C and HDL-C were found to be 11.5 %, 24.5 %, 13.5 % and 49 %, respectively [Table/Fig-2].

The subjects were allotted one of the four groups I, II, III and IV according to their WC and BMI values. These four groups exemplified different obesity patterns. Of the 200 subjects, 77 were placed in Group I, 54 in Group II, 17 in Group III and 52 in group IV. The proportion of normal and abnormal lipid profile in these groups are shown in [Table/Fig-3]. The frequency of normal lipid parameters was highest in Group I, with 97.4 %, 92.2 %, 94.8 % and 77.9 % of the subjects having normal values for TC, TGL, LDL-C and HDL-C respectively. At the other end, the frequencies in the Group IV individuals, who had the most adverse lipid values, were 78.8 %, 51.9 %, 78.8 % and 23.07 % respectively. Groups II and III occupied an intermediate position in the spectrum with the frequency of normal lipid parameters better than that in Group IV, but worse than that in Group I.

The Pearson's co-efficient between the obesity indices and the lipid parameters yielded some significant correlations [Table/Fig-4].

Parameters	Male	Female	p-value
Age	43.19 ± 11.52	42.75 ± 11.81	0.79
TC	167.98 ± 31.88	168.48 ± 32.56	0.92
TGL	122.54 ± 40.85	117.36 ± 44.92	0.41
LDL-C	102.04 ± 30.21	101.63 ± 30.02	0.93
HDL-C	41.39 ± 14.71	45.08 ± 15.64	0.09
BMI	23.42 ± 3.17	23.46 ± 3.82	0.92
WC	83.63 ± 6.14	84.46 ± 7.76	0.4

[Table/Fig-1]: Gender-wise comparison of age, lipid profile values and anthropometric indices of obesity.
Values are expressed as mean±standard deviation; comparison between parameters was done by unpaired *t*-test

Variable	Normal	Abnormal
Waist circumference (WC)	131 (65.5 %)	69 (34.5 %)
Body mass index (BMI)	94 (47 %)	106 (53 %)
Total cholesterol (TC)	177 (88.5 %)	23 (11.5 %)
Triglycerides (TGL)	151 (75.5 %)	49 (24.5 %)
Low density lipoprotein cholesterol (LDL-C)	173 (86.5 %)	27 (13.5 %)
High density lipoprotein cholesterol (HDL-C)	102 (51 %)	98 (49 %)

[Table/Fig-2]: Proportion of normal and abnormal obesity indices and lipid values in the study sample.
Numbers outside parentheses indicate the counts. Numbers within parentheses indicate the proportions. Normal WC and normal BMI were defined by International Diabetic Federation [12] and World Health Organisation [13] criteria respectively Normal lipid profile values were defined by NCEP ATP III criteria [16]

		Group I	Group II	Group III	Group IV
No. of subjects		77	54	17	52
TC	Normal	75 (97.4 %)	47 (87.03 %)	14 (82.35 %)	41 (78.8 %)
	Abnormal	2 (2.6 %)	7 (12.97 %)	3 (17.65%)	11 (21.2 %)
TGL	Normal	71 (92.2 %)	41 (75.9 %)	12 (70.6 %)	27 (51.9 %)
	Abnormal	6 (7.8 %)	13 (24.1 %)	5 (29.4 %)	25 (48.1 %)
LDL-C	Normal	73 (94.8 %)	45 (83.3 %)	14 (82.35 %)	41 (78.8 %)
	Abnormal	4 (5.2 %)	9 (16.7 %)	3 (17.65 %)	11 (21.2 %)
HDL-C	Normal	60 (77.9 %)	22 (40.7 %)	8 (47.05 %)	12 (23.07 %)
	Abnormal	17 (22.1 %)	32 (59.3 %)	9 (52.95 %)	40 (76.93 %)

[Table/Fig-3]: Proportion of normal and abnormal lipid parameters in the four groups
The numbers outside the parentheses indicate counts. Numbers within parentheses indicate proportions. Normal lipid profile values were defined by NCEP ATP III criteria [16]

The WC values showed positive correlation (r > 1) with TGL and LDL-C levels, and negative correlation (r < 1) with HDL-C levels; and this was highly significant (p < 0.01). Likewise, the BMI values also showed positive correlation (r > 1) with TGL and LDL-C levels, and negative correlation (r < 1) with HDL-C levels; these relationships were also highly significant (p < 0.01).

The lipid profile parameters were compared amongst the four groups [Table/Fig-5]. The TC values were apparently highest in Group IV (174.98 ± 36.29 mg/dL) and lowest in Group I (163.87 ± 27.44 mg/dL). But these differences were not significant (p > 0.05).

Parameters	TC	TGL	LDL-C	HDL-C
WC	0.113	0.419*	0.263*	-0.429*
BMI	0.097	0.312*	0.248*	-0.403*

[Table/Fig-4]: Correlation analysis between anthropometric indices of obesity and lipid parameters
The values indicate Pearson's correlation coefficients (r). *p < 0.01, i.e. highly significant

Parameters	Group I	Group II	Group III	Group IV
TC (mg/dL)	163.87 ± 27.44	167.56 ± 33.51	168.71 ± 30.96	174.98 ± 36.29
TGL (mg/dL)	99.56^{a} ± 34.02	126.59^{b} ± 37.71	127.29^{b} ± 45.51	143.54^{b} ± 43.4
LDL-C (mg/dL)	92.43^{a} ± 27.09	105.52^{ab} ± 30.17	101.41^{ab} ± 31.77	112.29^{b} ± 30.18
HDL-C (mg/dL)	51.68^{a} ± 16.99	36.76^{b} ± 9.92	42.06^{b} ± 14.91	35.94^{b} ± 9.19

[Table/Fig-5]: Comparison of lipid parameters amongst the four groups.
The values are expressed as mean ± standard deviation; the statistical analysis was done by one-way analysis of variance (ANOVA), followed by post-hoc Tukey-Kramer test when the means were significantly different. Means in a row bearing a common superscript do not differ significantly

Sex	Dependent (outcome) variables	Independent (predictor) variables	Beta (β)	p-value	Model R^2
Male	TC	Age	0.272	0.28	
		BMI	0.462	0.73	0.032
		WC	0.553	0.43	
	TGL	Age	- 0.278	0.35	
		BMI	0.957	< 0.01	0.175**
		WC	2.39	0.55	
	LDL-C	Age	0.159	0.49	
		BMI	1.326	0.29	0.056
		WC	0.517	0.43	
	HDL-C	Age	0.165	0.13	
		BMI	-1.020	0.13	0.162**
		WC	-0.462	0.08	
Female	TC	Age	0.588	0.09	
		BMI	0.713	0.69	0.045
		WC	-0.305	0.74	
	TGL	Age	0.027	0.95	
		BMI	-3.821	0.09	0.235**
		WC	4.153	< 0.01	
	LDL-C	Age	0.391	0.19	
		BMI	0.737	0.65	0.135*
		WC	0.816	0.32	
	HDL-C	Age	0.137	0.32	
		BMI	0.267	0.71	0.336**
		WC	-1.324	< 0.01	

[Table/Fig-6]: Regression analyses showing the contributions of age and obesity indices on the lipid profile parameters in males and females.
R^2: co-efficient of determination, β (beta): regression co-efficient. R^2 explains the percent of variance in the lipid parameters that was explained by including age, BMI and WC as predictor variables in the regression models. (*p < 0.05, i.e. statistically significant, **p < 0.01, i.e. statistically highly significant).

The TGL values differed significantly amongst the four groups (p < 0.01), with Group IV exhibiting the highest values (143.54 ± 43.43 mg/dL), followed by Group III (127.29 ± 45.51 mg/dL), Group II (126.59 ± 37.71 mg/dL) and Group I (99.56 + 34.02 mg/dL) in that order. Post-hoc tests revealed that the TGL values were significantly different between Groups I and II (p < 0.01), between Groups I and III (p < 0.01) and between Groups I and IV (p < 0.05).

Levels of LDL-C also varied significantly amongst the four groups (p < 0.01). The highest values were observed in Group IV (112.29 ± 30.18 mg/dL), which was followed by Group II (105.52 ± 30.17 mg/dL), Group III (101.41 ± 31.77 mg/dL) and Group I (92.43 ± 27.09 mg/dL). Post-hoc tests showed that the LDL-C values differed significantly between Groups I and IV (p < 0.05).

Comparison of HDL-C levels showed that Group I individuals had the most favourable values (51.68 ± 16.99 mg/dL). This was followed by individuals in Group III (42.06 ± 14.91 mg/dL), Group II (36.76 ± 9.92 mg/dL) and Group IV (35.94 ± 9.19 mg/dL). This variation in HDL-C levels across the four groups was highly significant (p < 0.01). While the difference between Groups I and III was significant (p < 0.05), the differences between Groups I and II, and that between Groups I and IV were highly significant (p < 0.01).

The results of regression analyses are presented in [Table/Fig-6]. In males, the regression models significantly predicted the variance in concentrations of TGL (R^2 = 0.175, p < 0.01) and HDL-C (R^2 = 0.162, p < 0.01). In females, the regression models significantly explained the variance in TGL (R^2 = 0.235, p < 0.01), LDL-C (R^2 = 0.135, p < 0.05) and HDL-C (R^2 = 0.336, p < 0.01) levels. Moreover, in males, BMI showed independent association with TGL (p < 0.01). While in females, WC was independently associated with TGL and HDL-C (p < 0.01).

DISCUSSION

Dyslipidemia, a well-characterized risk factor for cardiovascular diseases, is particularly common in the people of Indian origin [17-20]. This is alarming because Asian Indians are one of the worst affected ethnic groups afflicted by cardiovascular diseases [21,22]. Obesity, which is thought to be strongly associated with dyslipidemia and poor cardiovascular outcomes, is another condition that is highly prevalent in Indians [8,19]. The present study attempted to explore the influence of obesity in influencing lipid profile in a local population of Guwahati, Assam, Northeast India; a region from where data in this regard is hitherto not available.

Low HDL-C was found to be the most common lipid abnormality with 49% of the study subjects exhibiting this trait. This was in agreement to the observation that low HDL-C is a consistent abnormality in Asian Indians that is seen across different geographical locations and societies [18-21]. The frequency of low HDL-C reported in this study is comparable to the ones reported in Mumbaikars [17] and Keralites [19]. In contrast, a multi-centric study by Indian Council of Medical Research (ICMR) found the prevalence of low HDL-C quite high (72.3 %) [21]. We found hypertriglyceridemia to be the next common lipid abnormality (24.5 %). This frequency was also similar to the ones reported in other Indian populations [19,21]. Likewise, the prevalence of increased LDL-C (13.5 %) and increased TC (11.5 %) observed in the current study were comparable to the ones reported by the ICMR multi-centric study [21]. But, this was lower than the frequency reported from Kerala [19]. These differences in the prevalence of lipid abnormalities are perhaps attributable to the different sampling techniques and the diverse lifestyles and genetic background of the participants.

In our sample, WC and BMI individually displayed significant positive correlation with TGL and LDL-C values and negative correlation with HDL-C values. These results are in agreement with studies conducted on other populations like Mexican Americans [4], Brazilians [5], Tanzanians [6], non-Hispanic whites [23], Chinese [24], French Canadians [25], Spanish [26] – all of which indicate that

WC and BMI values correlate positively with TGL and LDL-C levels, and negatively with HDL-C levels. A similar trend is reflected in other Indian populations as well [9].

Thus, significantly higher levels of TGL and LDL-C, and lower levels of HDL-C co-existed with high values of WC and BMI in the current population. In other words, unfavourable lipid profile was found to be concurrently present with obesity. This was further supported by the observations made while comparing the mean lipid levels between the four groups that were classified on the basis of WC and BMI values. Group IV individuals who had both increased WC and increased BMI exhibited the most abnormal values for all the lipid profile components. In contrast, the Group I subjects who had both normal WC and BMI were at the other end of the spectrum with the most favourable lipid profile values. It was found that subjects in the Groups II (normal WC, increased BMI) and III (increased WC, normal BMI) in which only one of the anthropometric indices of obesity was increased showed intermediate lipid profile values in between these two extremes. Therefore, presence of both increased WC (centralised obesity) and increased BMI (generalised obesity/overweight) seemed to cause more abnormal lipid profile as compared to the presence of only one of these factors. These findings are in concordance with that of Joo et al., [27].

Other studies, reporting the influence of WC and BMI on lipid profile have observed that lipid profile in individuals with centralised obesity (increased WC) or with generalised obesity/overweight (increased BMI) was adverse as compared to non-obese individuals [4,23-25,28,29]. However, most of the previous studies have examined the role of these obesity indices separately. A strength of present study was that we took into account the influence of both these indices together, providing information on the variability in lipid levels along a continuum of obesity patterns, represented by the four groups.

Further, to ensure that the variation in the lipid profile observed across the obesity patterns were not confounded by the age and gender composition of the study sample, the univariate analyses results were complemented by multivariate regression results obtained separately for the two sexes. When WC, BMI and age of the male subjects were included as covariates, they significantly influenced the levels of TGL and HDL-C. In females, these variables significantly affected the concentrations of TGL, HDL-C and LDL-C. These relationships remained significant even after age was excluded from the regression models in both the sexes. Independently, only WC was identified as a significant determinant of lipid profile in females. It influenced TGL and HDL-C values. In males, only BMI independently influenced the TGL values. Age alone did not significantly influence any lipid parameter in either sex.

The present study was performed in a single city in order to enhance the internal validity and prevent true associations being obscured by a heterogenous sample. Guwahati is a fast growing city. The people of Assam are often alleged to be averse to hard labour. The wet and humid climate of the state and the easy going attitude of the people are the most commonly cited reasons [30]. Rapid urbanisation in Guwahati has led to major shifts in the occupation, improvement in socio-economic status and an easy lifestyle, which is likely to contribute to the sedentary behaviour further. Besides, there is a conspicuous shift in dietary patterns in urban India with greater consumption of sugars, fats and carbohydrates and increased intake of processed and ready-to-eat foods [31]. Guwahati is no exception to this trend. Future efforts should be geared towards identifying the causes of obesity in rapidly modernizing transitional societies like the current one.

LIMITATIONS

We could not take into account the contribution of diet and socio-economic factors in influencing lipid profile and obesity. Besides, a randomly drawn larger sample would have been more desirable. Limited resources and time constraint were the chief causes for these limitations.

CONCLUSION

The results indicate that serum lipid profile values were significantly affected by obesity irrespective of age and gender in a sample population from Guwahati, Assam, in northeast India. We found that more the extent of obesity more was the extent of dyslipidemia. Subjects who were neither centrally nor generally obese had the best lipid profile values as compared to subjects who were either centrally or generally obese, followed by subjects were both centrally and generally obese. This has important implications because dyslipidemia predisposes to cardiovascular disorders. However, obesity being a modifiable risk factor, implementing effective primary and secondary preventive measures to combat obesity can curb its detrimental effects on the lipid profile and hence on cardiovascular disorders. It is hoped that the information generated by this study would encourage further studies to identify the causes of obesity that would help in better understanding of its influence on lipid profile.

ACKNOWLEDGEMENT

The authors acknowledge the valuable inputs of Dr. Chandana Bhattacharjee, PhD (Anthropology), Women's College, Shillong.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jun 23, 2015**
Date of Peer Review: **Aug 10, 2015**
Date of Acceptance: **Sep 14, 2015**
Date of Publishing: **Nov 01, 2015**