Anthropometric correlation of lipid profile in healthy aviators

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ABSTRACT

Hyperlipidemia is commonly ascribed to obesity. In the current study, the association of anthropometric profile with hyperlipidemia after adjustment for important confounding variables such as smoking, alcohol intake, and diabetes in healthy male volunteers was analysed. Two hundred and forty five aircrew reporting for medical examination prior to renewal of aircrew license formed the study group. Anthropometric assessment included measurement of weight, height, waist and hip circumferences. Body fat (BF) was measured by electrical bioimpedance. Serum levels of total cholesterol (TC), High-density lipoprotein-cholesterol (HDL-C) and triglyceride (TG) were measured. Low-density lipoprotein-cholesterol (LDL-C) was calculated by the Friedewald formula. Statistical analysis was done to examine the associations between anthropometric variables and lipids. Mean age of the study population was 41.2 ± 10.2 yrs (20 to 63 yr). Seventy two percent of the study population had BMI >25 kg/m^2, with 63% having BF more than 25%. In 51.3% waist hip ratio (WHR) was more than 0.9 and 48% had waist circumference more than 90 cm. Hypertriglyceridemia (36%) was the commonest abnormality noted followed by low HDL-C levels (18%). Lipid sub fraction analysis revealed that elevated cholesterol and LDL-C correlated to BMI ($r = 0.2, p = 0.002$) and body fat % ($r = 0.16, p = 0.015$), while triglyceride and VLDL correlated with WHR ($r = 0.15, p= 0.020$). In older men, BMI correlated positively with elevated cholesterol ($r = 0.36, p < 0.001$) while WHR correlated positively with triglycerides ($r = 0.42, p < 0.001$). However, in the younger men, BF positively correlated with elevated cholesterol ($r = 0.40, p < 0.001$). Waist circumference did not correlate with dyslipidemia in any subgroup. Combination of anthropometric variables predicts dyslipidemia better in asymptomatic healthy males rather than any one particular variable.

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The World Health Organization (WHO) defines obesity as a condition with excessive fat accumulation in the body, to the extent that health and well being are adversely affected [1]. It has been widely accepted that excess body fat (BF) and obesity constitute risk factors for diabetes [2], cardiovascular disease [3], hypertension [4], gall bladder disease [5] and dyslipidemia [6]. Various lipid/lipoprotein abnormalities have been observed in obese individuals, including elevated cholesterol, triglycerides, and lower high-density lipoprotein (HDL) cholesterol levels. Of these indicators, changes in triglyceride and HDL cholesterol levels are most consistent and pronounced [7]. These adverse lipid/lipoprotein profiles in obese individuals are important, because they may be responsible for their increased risk for cardiovascular disease (CVD). Despite several

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publications on the relation between anthropometric markers and lipid profile, the best anthropometric index of fat location remains controversial. Controversies may be explained in part by differences in body composition and fat distribution in different racial groups, age groups, and sexes [8].

However, to evaluate the association of markers of obesity with dyslipidemia, analysis should be adjusted for overall adiposity. Body mass index (BMI) is widely used as a marker of adiposity, but it may not be a good measurement of fatness, mainly in extremes of stature and with advancing age [9]. In addition the strength of the relationship between BMI and body fat percentage (BF %) varies between populations and ethnic groups, implying that a BMI-based classification of weight status would necessarily be population specific [10]. It was thought worthwhile to test the credibility of other variables such as waist circumference, waist hip ratio and BF% in predicting serum concentrations of lipids and lipoproteins. In the present study, we have tried to correlate the anthropometric variables with lipid profile in a randomly selected aircrew population after adjusting for other confounding variables.

Material and Methods

This study was carried out from Aug 2005 to Jan 2006 at the Air Force Central Medical Establishment, New Delhi. Healthy, non-diabetic, normotensive, male aircrew reporting for medical examination prior to renewal of flying license constituted the study population. Informed consent was obtained from all the volunteers after full explanation of the procedure. The subjects participated in the medical examination in the morning after fasting overnight. After taking a brief medical history, a detailed physical examination was conducted for all participants.

Anthropometry. Anthropometric assessment included a record of height, weight, waist circumference (WC) and hip circumference. Body mass was evaluated with an electronic scale, which is a part of the body composition analyzer (model TBF-305, Tanita, Tokyo, Japan), with a variation of 200 gm. WC and hip circumference were measured in duplicate to the nearest 0.5 cm with a flexible but inelastic measuring tape while the subject was standing relaxed. Waist was taken at the level of the natural waist (the narrowest part of the torso). The hip circumference was measured at the maximum circumference of the buttocks posteriorly and the symphysis pubis anteriorly, in a horizontal plane [11]. BMI was calculated by dividing the body weight (in kilograms) by the square of height (in meters).

The electronic scale, used to measure weight was reset before every weighing procedure and body mass and leg-to-leg impedance were measured simultaneously with the subject's bare feet making pressure contact with the electrodes. Assuming uniform hydration of the fat free mass and little variation in the body geometry, (limiting factors in fat estimation by this method) a variation of 200 gm was acceptable.

Investigations. Venous blood was drawn for biochemical examination which included blood glucose and lipid profile. Total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C) and triglyceride (TG) were estimated directly while low-density lipoprotein-cholesterol (LDL-C) was calculated by the Friedewald formula.

Definition. Obesity was defined as BMI greater than 25 kg/m^2 [12]. The cut off values used for BF %, WC and WHR as a reference for analyzing its relation to dyslipidemia were greater than 25%, 90 cm and 0.91, respectively [13]. Dyslipidemia was defined as abnormal levels of at least one of the serum lipids (LDL-C, HDL-C or TG) as per the criteria of the National Cholesterol Education Program, Adult Treatment Panel III [14].

Statistical analysis. Data was recorded on a predesigned performa and managed in a Microsoft Excel spreadsheet. All the entries were double-checked for any possible keyboard error. The data was subjected to statistical analysis using software Statistica Version 5. The correlation coefficient was worked out to find out the degree of association between anthropometric parameters on the one-side and lipid fractions on the other.

Results

Two hundred and forty five civil aircrew were enrolled for the study. The mean age of the study population was 41.2 ± 10.2 yrs (20 to 63 yr). Majority of the individuals (36%) were in the age group of 30-39 years. The anthropometric indices have been summarized in Table 1. Seventy percent of the study population had BMI >25 kg/m², while 63% of the study population had BF% more than 25%. In 51.3% of the cases, WHR was more than 0.9 and 47% had waist more than 90 cm. High values of BMI and BF % were noted in the study population. Lipid sub fraction analysis revealed hypertriglyceridemia to be the commonest abnormality, noted in 36% of the study population followed by low HDL-C levels noted in 18% (Table 2).

Overall analysis of data revealed that cholesterol and LDL-C were correlated significantly with BMI (r =0.1962, p=0.001) and BF% (r =0.2324, p=0.018). Triglycerides correlated positively with WHR (r = 0.1486, p=0.020) while HDL-C and TC / HDL-C ratio >5 correlated negatively with WHR (r= -0.2808, p=0.042) (Table 3).

Anthropometric correlation with lipid sub fractions in the various age groups as given in

Table 1 : Age distribution and basic anthropometric profile

		n=245	Mean Value
Age (Yrs)			41.2 ± 10.2
	<30	30 (12%)	
	30 - 39	88 (36 %)	
	40 - 49	69 (28%)	
	50 - 59	43 (17.5%)	
	>60	15 (6.5%)	
BMI (kg/m²)			26.02 ± 3.38
	<25	72 (29.3%)	
	25 - 30	149 (61%)	
	>30	24 (9.7%)	
Body Fat %			31.14 ± 6.58
	<20	7 (2.8%)	
	21 - 25	108 (34.2%)	
	26 - 30	111 (55.3%)	
	>30	19 (7.7%)	
WHR			0.90 ± 0.04
	<0.9	119 (48.6%)	
	>0.9	126 (51.4%)	
Waist (cm)			89.24 ± 6.23
	<80	13 (5.4%)	
	80 - 84	38 (15.5%)	
	85 – 89	78 (31.8%)	
	90 – 94	78 (31.8%)	
	>95	38 (15.5%)	

Table 4, revealed that BF % correlated with elevated cholesterol in the younger pilots (r = 0.3952, p = 0.034), while in older pilots BMI correlated positively with elevated cholesterol (r = 0.36, p < 0.001). WHR correlated positively with hypertriglyceridemia (r = 0.42, p < 0.001) and negatively with HDL-C (r = -0.0582, p = 0.019). WC did not show any correlation with any of the anthropometric variables. In general, it was found that the magnitude and strength of the associations between anthropometric measures and serum lipids was greatest among subjects in the age group of 50-59 years.

Discussion

The study examined the relationship

Table 2 : Lipid profile (n=245)

	No. (%)	Mean Value
Cholesterol (mg/dl)		205.70 ± 33.24
<150	4 (2%)	
150 - 199	117 (47%)	
200 - 249	102 (42%)	
>245	22 (9%)	
Triglycerides (mg/dl)		160.47 ± 68.20
<160	157 (64%)	
160 - 199	36 (15%)	
>200	52 (21%)	
HDL (mg/dl)		47.69 ± 4.72
35 – 45	43 (18%)	
>45	202 (82%)	
VLDL (mg/dl)		32.17 ± 13.74
<25	83 (34%)	
25 – 35	91 (37%)	
>35	71 (29%)	

Table 3 : Correlation coefficient analyses between variables of obesity and lipid profile

	TC	LDL-C	HDL-C	TG	VLDL
BMI	0.1962*	0.1357*	0.0289	0.0448	0.0264
FAT	0.2324***	0.1546**	0.026	0.122	0.1041
WHR	0.0929	0.0528	-0.0116	0.1486*	0.1314*
WAIST	-0.0633	-0.1171	0.0107	0.0554	0.0523

*p<0.05, **p<0.01, ***p<0.001

between obesity and lipid/lipoprotein profiles and the effects of total obesity and central adiposity on lipids/ lipoproteins. A lower cutoff values of BMI to define overweight (23 kg/m^2), obesity (25 kg/m^2) and lower limits of waist circumference (WC) to define abdominal obesity have been proposed for South Asians by the WHO and the same were used in this study [12]. Based on these parameters, a high prevalence of obesity was noted in our study group compared to what has been noted in other urban studies on obesity from our country [15, 16]. The mean value of the BMI recorded in the present study was 26.02±3.3

Table 4 : Correlation coefficient of lipid sub fractions to variables of obesity in various age groups

	20 – 29 yrs	30 – 39 yrs	40 – 49 yrs	50 – 59 yrs	> 60 yrs
Cholesterol					
BMI	0.3221	0.1971	0.0524	0.3645*	0.0049
FAT	0.3952*	0.1576	0.20	0.3246*	-0.0778
WHR	0.1586	0.028	-0.153	0.391**	0.1007
WAIST	-0.0326	-0.0783	-0.3118**	0.050	0.2528
Triglycerides					
BMI	0.3507	0.0828	-0.2071	0.0217	0.4185
FAT	0.3182	0.0861	0.1718	0.0091	0.2819
WHR	0.1984	0.053	-0.0195	0.4159**	0.2512
WAIST	0.0423	0.0763	-0.0462	0.0612	0.2458
HDL-C					
BMI	-0.0005	0.0594	0.0395	0.0669	0.3618
FAT	0.1574	0.0643	-0.0963	0.0635	-0.2811
WHR	0.1525	-0.0613	0.0032	-0.1476	-0.0582*
WAIST	0.0698	0.0427	-0.1075	-0.1358	0.5552

*p<0.05, **p<0.01, ***p<0.001

kg/m^2. This is akin to data derived from migrant Indians [17]. This probably was because our study group was from higher socio-economic strata and was not a true representative of the population.

Lipid abnormalities noted in the present study reveal hypertriglyceridemia to be the most common lipid abnormality followed by low HDL-C levels. This is in conformity with other Indian studies [18]. The magnitude of changes in lipids/ lipoproteins with obesity in nondiabetic participants were in most cases small, which suggests that obesity may be a less important factor in determining lipid/lipoprotein levels in this population than in others. Some studies have shown a positive association between lipid levels and measures of adiposity [18,19], whereas other studies have failed to detect such a relationship [20, 21]. In the present study, even though BMI correlated with cholesterol and LDL-C levels, it did not correlate with elevated TG and HDL-C levels. BMI has been widely used as an indicator of total adiposity; its limitations are clearly recognized by its dependence on race (Asians having large percentages of body fat at low BMI values), and age. As compared to BMI, WC and WHR have been used as surrogates of body fat centralization. The strength of association of WHR and WC with dyslipidemia has been variable in different studies. In the present study, hypertriglyceridemia correlated more with WHR than WC. These findings are consistent with those of several previous studies [22, 23]. WHR may be more important than WC in Asian Indians for the detection of abdominal obesity. A simple explanation may be that the absolute value of WC may not be high in Asian Indians, whereas hip circumference may be relatively less, thus producing high values of WHR. Low values of hip circumference may occur due to less lean mass in the lower extremities in Asian Indians as compared with other ethnic groups [23]. Unlike other investigators [18, 22] who found, the magnitude and strength of the associations between anthropometric measures and serum lipids in younger subjects, we found the same more in older subjects.

No single anthropometric variable was able to predict dyslipidemia, hence while dealing with dyslipidemic Indians, physicians should consider combination of anthropometric parameters like WHR and %BF, in addition to BMI.

Conclusion

A high incidence of obesity was noted in the healthy aviators who showed associated lipoprotein abnormality. Combination of anthropometric variables predicted dyslipidemia better in these healthy volunteers than any one particular variable.

References

1. World Health Organization. Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation on Obesity, Geneva, 3–5 June 1997. WHO/ NUT/NCD/98.1. WHO: Geneva, 1998.

2. Fujimoto WY. Overview of non-insulin-dependent diabetes mellitus (NIDDM) in different population groups. Diabetes Mellitus 1996; 13: S7-S10.

3. Rexrode KM, Manson JE, Hennekens CH. Obesity and cardiovascular disease. Curr Opin Cardiol 1996; 11:490-95.

4. The Trials of Hypertension Prevention Collaborative Research Group. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure: The Trials of Hypertension Prevention, Phase II Arch Int Med 1997;157:657-67.

5. Misciagna G, Leoci C, Cuerra V. Epidemiology of cholelithiasis in southern Italy : Part II: Risk factors. Eur J Gastroenterol Hematol 1996;8: 585-93.

6. Ding YA, Chu NF, Wang TW, Lin CC. Anthropometry and lipoproteins related characteristics of young adult males in Taiwan. Int J Obes Relat Metab Disord 1995;19:392-96.

7. Depres JP. Obesity and lipid metabolism: relevance

of body fat distribution. Curr Opin Lipidol 1991; 2:7-15

8. Misra A, Wasir JS, Vikram NK. Waist circumference criteria for the diagnosis of abdominal obesity are not applicable uniformly to all populations and ethnic groups. Nutrition 2005; 21:969-76.

9. Smalley KJ, Knerr AN, Kendrick ZV, Colliver JA, Owen OE. Reassessment of body mass indices. Am J Clin Nutr 1990; 52: 405–08.

10. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta analysis among different ethnic groups. Int J Obes Relat Metab Disord 1998; 22:1164-71.

11. Callaway CW, Chumlea WC, Bouchard C. Circumferences. In: T.G. Lohman, A.F. Roche and R. Martorell, editors: Anthropometric standardization reference manual. Human Kinetics Books, Champaign, IL 1988; 39.

12. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet, 2004; 363 (9403):157-63.

13. Snehalatha C, Viswanathan V, Ramachandran A. Cutoff values for normal anthropometric variables in Asian Indian adults. Diabetes Care 2003;26:1380-84.

14. Executive summary of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). JAMA 2001; 285:2486.

15. Gopinath N, Chadha SL, Jain P, Shekhawat S, Tandon R. An epidemiological study of obesity in adults in the urban population of Delhi. JAPI 1994; 42: 212-15.

16. Rao VK, Rau P, Thimmayamma BVS. Nutritional anthropometry of Indian adults. Indian J Nutr Dietetics 1986; 23:239–56.

17. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet 1991; 337: 382-86.

18. Misra A, Luthra K, Vikram NK. Dyslipidemia in Asian Indians: Determinants and significance. JAPI 2004; 52:137-42.

19. Hu D, Hannah J, Gray S. Effects of Obesity and Body Fat Distribution on Lipids and Lipoproteins in Nondiabetic American Indians: The Strong Heart Study. Obesity Research 2000; 8:411-21.

20. Walton C, Lees B, Crook D, Worthington M, Godsland IF, Stevenson JC. Body fat distribution, rather than overall adiposity, influences serum lipids and lipoproteins in healthy men independently of age. Am J Med 1995; 99:459-64.

21. Chumlea WC, Baumgartner RN, Garry PJ, Rhyne RL, Nicholson C, Wayne S. Fat distribution and blood lipids in a sample of healthy elderly people. J Obes Relat Metab Disord 1992; 16:125-33.

22. Leenen R, van der Kooy K, Droop A. Visceral fat loss measured by magnetic resonance imaging in relation to changes in serum lipid levels of obese men and women. Arterioscler Thromb 1993; 13:487-94.

23. Chandalia M, Abate N, Garg A, Stray-Gundersen J, Grundy SM. Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. J Clin Endocrinol Metab 1999; 84: 23-29.