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RESEARCH ARTICLE

OBESITY ALONE COULD GIVE RISE TO ALTERED LIPID PROFILE: A STUDY AMONG APPARENTLY HEALTHY ADULTS IN SRI LANKA

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ABSTRACT

Introduction: WHO has estimated that 75 % of deaths in developing countries will be due to obesity related diseases. Hence, this study was conducted to assess the lipid profile in apparently healthy Sri Lankan subjects who were not diagnosed with any chronic or major diseases (apparently healthy).

Methods: An interviewer administered questionnaire was used to obtain socio demographic data. Blood samples obtained from individual participants after 12 hours overnight fast was tested for lipid profiles. Anthropometric measurements were obtained according to standard procedures. All data were analyzed using the Statistical Package for Social Sciences version 17 and p-value< 0.05 was considered statistically significant.

Results: The mean age of the population was 38 (± 12SD) years. The percentages of overweight (21.3%) and obese (35.6%) were comparatively high even though the subjects were apparently healthy. Further, the percentage of males with abdominal obesity (41.8%) was higher than that of females (23.0%). All the lipid parameters, except HDL-C were elevated in the obese group compared to non-obese even though both means were within the normal range; but among the obese subjects 46 % had elevated TC (>5.1 mmol/L) and 42.3% had elevated LDL-C (> 3.4 mmo/L). There was a significant increase in TC/HDL with increasing BMI.

Conclusion: This study contributes to the finding that the percentage of overweight and obesity is very high in Sri Lanka. Though the study population was apparently healthy, the percentage of obese subjects with altered lipid profile was higher indicating the necessity for an effective screening process.

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INTRODUCTION

Globally obesity is the fifth leading risk factor of death and causes around 2.8 million deaths each year (WHO 2012). The worldwide prevalence of obesity had increased from 28.8 % to 36.9 % in men and from 29.8 % to 38.0 % in women from 1980 to 2013 (Ng *et al*., 2014). WHO has estimated and indicated that three quarter of deaths will be due to obesity related diseases in developing countries by 2020 (Kelishadi, 2007). Incidence of overweight and obesity is steadily increasing in the urban settings of low and middle income countries; and the prevalence is very high in the South East Asian region. According to a study reported in 2012 the prevalence of overweight (17.1%) and obesity (28.8 %) among Sri Lankan adults has increased (Jayawardena *et al*., 2012). This is mainly attributed to economic growth, affluence, urbanization, change in diet pattern and genetic predisposition. A complex interaction between environmental and genetic factors that enhances fat accumulation results in obesity. This results in prolonged energy imbalance and insufficient energy expenditure. In addition, less physical activity and excess energy intake from a hyper energetic di*et al*so contribute to the above. Obesity is assessed by anthropometric measurements and/or indices. Most commonly used indices are Body Mass Index (BMI) and Waist to Hip ratio (WHR). Obesity leads to the development of several diseases, such as insulin resistance type 2 diabetes, arterial hypertension and dyslipidaemia; which collectively give rise to the metabolic syndrome as well as cardiovascular diseases (CVD). Obesity and overweight accounts for 44 % of diabetes mellitus and 23 % of CVD burden in the world (Misra and Shrivastava, 2013). Dyslipidaemia is defined as abnormalities in serum lipids and lipoproteins levels, where increased levels of total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), decreased level of high density lipoprotein cholesterol (HDL-C) and hyper triglyceridaemia are present alone or in combination. The association between dyslipidaemia and obesity is well identified. South Asians are facing a growing epidemic of obesity associated dyslipidaemia. Most of the obese individuals have increased levels of LDL-C, TG and decreased level of HDL-C than the normal recommended values. This is the

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characteristic feature of atherogenic lipid profile which is implicated in the genesis of CVD. Both obesity and dyslipidaemia are risk factors of CVD and this may account for premature death in obese population. Behavioural changes, physical activities and healthy diet pattern may reduce the risk of obesity and may help to maintain a normal BMI. This may reduce the risk of developing other diseases including dyslipidaemia, CVD and premature death. As anthropometric measurements such as BMI are less costly methods, it is essential to educate subjects to monitor their BMI and to take precautions in order to avoid CVD and early mortality.

Documented data which are available to show the impact of obesity among Sri Lankan adults are limited. Therefore, this study was conducted to assess the impact of obesity on lipid profile and the effects of socio demographic factors on lipid profile among apparently healthy volunteers who did not have any complicated diseases and who were not aware about dyslipidaemia. This study finding will aid to prepare new strategies or interventions to prevent and control obesity as well as morbidity and mortality due to CVD.

MATERIALS AND METHODS

Classification of the study population

The study population was classified as overweight (BMI > 23.0 kg/m^2), obese (≥ 25.0 kg/m^2) and normal (BMI-8.5 kg/m^2 - 22.9 kg/m^2) (Low *et al*., 2009). The classification based on WHR was done separately for men and women. The WHR risk cut off values were considered as ≥ 0.90 for men and ≥ 0.85 for women. Risk group of people for WHR are obese (abdominal obesity) and they are at risk of developing metabolic related diseases (metabolic syndrome) in years to come (WHO 2011). The categorization of the population based on the lipid parameters were done according to the cut off values recommended by the National Cholesterol Education Program (NCEP) third adult treatment panel (ATP III) guidelines (Adult Treatment Panel III, 2002).

Study design

The study design was a cross-sectional study. Non probability, convenience sampling technique was used to recruit 216 volunteers for the study. The study protocol was approved by the Ethics Review Committee of Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka. All standard ethical procedures were adhered. Informed written consent was obtained from all the participants prior to the study.

Subjects

The study was limited to non-diabetic adults who were aged between 21- 69 years, without a past history of myocardial infarction, heart failure and cancer. Those who were previously diagnosed as hypertensive, hypercholesteraemic and pregnant women were excluded in this study.

Method

Information on socio-demographic factors (age, gender, area of residence, ethnicity, level of education, occupation and monthly income) and behavioural factors (smoking and alcohol consumption) were obtained with the aid of an interviewer administered questionnaire. Height, weight, waist circumference (WC) and hip circumference (HC) were measured according to standard recommended procedures. Anthropometric indices, BMI [weight (kg)/height (m^2)] and WHR (WC/HC) were calculated.

Blood sampling

An overnight 12 hours fasted blood sample was collected from all the participants adhering to universal precautions and standard procedures. Separated serum was stored and was tested in duplicates within 2-3 days for TC, HDL-C and triglyceride (TG) by the enzymatic kit method (Stanbio® kits) based on Beer-Lambert law. LDL-C was calculated using Friedewald equation (LDL-C= [(TC)-(HDL-C)-(TG/2.2)]. TC/HDL-C, LDL-C/HDL-C and TG/HDL-C ratios were calculated.

Statistical analysis

Data were analysed by Statistical Package for Social Sciences (SPSS) software version 17.0. Independent sample t-Test was carried out to find out the impact of obesity on lipid parameters. For t-Test analysis the population was classified into two groups, normal (< 23 kg/m^2) and obese (≥23 kg/m^2). The p-values less than 0.05 were considered as statistically significant.

RESULTS

Population characteristics

Among the 216 apparently healthy subjects, majority (59.7%) were females. They were between 21- 69 years with the mean age of 38 (± 12SD) years. Most of the participants were educated young adults (58.8%) and were residing in urban areas (68.1%). Majority (69.4%) of them had higher monthly income (approximately above USD 170) compared to the general Sri Lankan incomes (Table 1). Among the obese population 56.4% were young adults (20-40 years), 70.5% were urban residents and 29.5% were sub-urban residents. The mean value of BMI of the total population was 23.8 ± 4.0 kg/m^2. Among the participants the percentage of overweight (21.3%) and obesity (35.6 %) were comparatively high compared to the previous studies. The BMI value of obese population ranged between 25.0-36.2 kg/m^2. Furthermore there was no significant difference between the mean values of BMI in males (23.9 ± 3.5 kg/m^2) and females (23.8± 4.4 kg/m^2). The percentage of abdominal obesity among males (41.8%) was higher than that of females (23.0%) in this study population (Table 2). WHR values ranged between 0.69 -1.01 in males and 0.69 - 1.20 in females. All the mean lipid parameters were within the recommended range in the normal BMI group. Further, all the lipid parameters except HDL-C were elevated in the obese group compared to normal. HDL-C was lower in obese group than the normal subjects. More than half the population (63.9%) had TC less than 5.1 mmol/L. Even though, the mean value for TC in the obese population was lower than 5.1 mmol/L, (within normal range) it was higher than the mean value of the population with normal BMI (Table 3). In addition about 46% of obese population had elevated TC (> 5.1 mmol/L). More than three quarter of the participants had normal HDL-C and about 22% were with low HDL-C. High level (>3.4 mmo/l) of LDL-C concentration was observed in 34% of the total population and 42.3% of obese population.

Table 1. Socio-demographic factors of the study population

Socio-demographic factors	Category	Percentage (%)
Age	Young adult (20-40 years)	58.8
	Middle adulthood (41-55 years)	29.2
	late adult hood(>56 years)	12.0
Area of residence	Urban	68.1
	Sub-urban	29.2
	Rural area	2.8
Level of education	None	0.9
	Primary	9.7
	Secondary	50.9
	Tertiary	38.4
Occupation	Professional	2.8
	Semi professional	6.5
	Lesser professional	17.6
	Skilled	39.4
	Non skilled	7.4
	None	26.4
Monthly income	< $ 50	9.7
	$ 50- $174	20.9
	$ 175 - $275	31.9
	Above $ 275	37.5
Smoking	Never	89.4
	Current smokers	7.9
	Former smokers	2.8
Alcohol consumption	Non consumers	77.8
	Irregular alcohol consumers	19.0
	Regular alcohol consumers	3.2

Table 2. Mean values of anthropometric indices and the percentages

BMI			WHR		
Category	%	Mean ± SD	Category	%	Mean ± SD
Underweight	11.6	17.5 ± 0.9	Male		0.88 ± 0.06
Normal	31.5	21.1 ± 1.3	Non risk	58.2	0.84 ± 0.04
Over weight	21.3	24.1 ± 0.6	Risk	41.8	0.94 ± 0.03
Obese	35.6	28.0 ± 2.6	Female		0.84 ± 0.08
Total population		23.8 ± 4.0	Non risk	77.0	0.80 ± 0.05
			Risk	23.0	0.95 ± 0.08

*BMI: Body mass index (kgm^{-2})
† WHR: Waist / hip ratio

Table 3. Associations between lipid parameters and anthropometric indices among obese and non- obese subjects

Lipid Parameters compared with anthropometric indices	Mean value ± SD (mmol/L)		t value	p value
	Non obese/ Non risk	Obese/ Risk		
1.With BMI				
TC	4.8± 1.4	5.0±1.1	-0.651	0.515
HDL	1.4 ± 0.4	1.2 ±0.3	2.936	0.004*
LDL	3.0 ±1.1	3.1 ± 1.1	-0.932	0.353
TG	1.5 ±0.7	1.5 ± 0.9	-0.869	0.386
TC/HDL	3.4 ± 2.7	4.2± 1.6	-2.148	0.033*
LDL/HDL	2.1±2.7	2.6± 1.5	-1.922	0.056
2.With WHR in Males				
TC	4.8 ±1.0	5.1 ±1.2	-0.825	0.412
HDL	1.3 ± 0.5	1.2 ±0.3	0.969	0.335
LDL	3.0 ±1.0	3.0 ±1.1	-0.148	0.883
TG	1.3 ± 0.6	1.9 ± 0.4	-2.520	0.014*
TC/HDL	3.6 ± 1.9	4.3 ± 1.1	-0.543	0.588
LDL/HDL	2.3 ± 1.7	2.5 ± 1.5	-0.132	0.895
3.With WHR in Females				
TC	5.0 ±1.2	4.9 ±1.2	0.525	0.600
HDL	1.3 ± 0.3	1.3 ± 0.3	-0.169	0.866
LDL	3.1 ± 1.2	2.9 ±1.1	0.832	0.407
TG	1.4 ±0.7	1.4 ±0.5	0.103	0.918
TC/HDL	3.9 ± 1.7	3.8 ± 1.2	0.704	0.483
LDL/HDL	2.4± 1.4	2.2 ± 1.1	1.027	0.306

*statistically significant ($p<0.05$)
†TC- Total cholesterol
‡HDL-High Density Lipoprotein cholesterol
§LDL-Low Density Lipoprotein cholesterol
‖TG-Tri glyceride

Table 4. Correlation between lipid parameters and anthropometric indices

Parameters	Correlation	r value	p value
1.Lipid parameters		BMI	
TC	Positive	0.090	0.187
HDL	Negative	-0.179	0.008*
LDL	Positive	0.081	0.237
TG	Positive	0.114	0.094
TC/HDL	Positive	0.143	0.036*
LDL/HDL	Positive	0.109	0.112
TG/HDL	Positive	0.168	0.013*
2.Lipid parameters		WHR in males	
TC	Positive	0.268	0.012*
HDL	Negative	-0.209	0.052
LDL	Positive	0.214	0.046*
TG	Positive	0.286	0.007*
TC/HDL	Positive	0.246	0.022*
LDL/HDL	Positive	0.206	0.056
TG/HDL	Positive	0.286	0.007*
3.Lipid parameters		WHR in females	
TC	Negative	-0.047	0.600
HDL	Positive	0.015	0.866
LDL	Negative	-0.074	0.407
TG	Negative	-0.009	0.918
TC/HDL	Negative	-0.062	0.483
LDL/HDL	Negative	-0.091	0.306
TG/HDL	Positive	0.007	0.934

*statistically significant ($p<0.05$)
†TC- Total cholesterol
‡HDL-High Density Lipoprotein cholesterol
§LDL-Low Density Lipoprotein cholesterol
╟TG-Tri Glyceride

About 60% of obese people had increased level of TG/HDL and 30% had high TC/HDL. All the smokers and alcohol consumers were males; but 89.4% had never smoked and 77.8% had never consumed alcohol in their life time (Table 1). Among the current smokers 83.3% were obese. Also, among the irregular alcohol consumers and regular alcohol consumers 29.3% and 42.9% were obese respectively. Smokers had elevated levels of all three lipid ratios, where 83% with high TC/HDL, 67% with high LDL/HDL and 70% with high TG/HDL. All the parameters of lipid profile, except HDL-C positively correlated with BMI and WHR in males. HDL-C had a negative correlation with BMI and WHR in males and a positive correlation with WHR in females. With an increase in BMI, TC/HDL and TG/HDL increased significantly. Even though TC, LDL, TG and TC/HDL significantly correlated with WHR in males but no significant correlations were found in females for WHR and lipid profile parameters. Most of the lipid parameters (TC, LDL, TG, TC/HDL and LDL/HDL) negatively correlated in females with WHR. Further, all the correlations between the lipid parameters and WHR in females were weak (Table 4).

According to the BMI classification obese populations are more likely to have elevated lipid parameters except HDL-C. The association with HDL-C and obesity and TC/HDL were significant. Higher mean values of lipid parameters in the obese population indicate the higher percentage of dyslipidaemia among obese population. All the lipid parameters, except HDL-C were elevated in risk group of WHR in males. There was no difference between the mean values of LDL-C in risk or non-risk group of WHR in males. The TG level significantly increased with the WHR in males. In females TC, LDL-C, TC/HDL and LDL/HDL were higher in non-risk group compared to the risk group and HDL-C and TG were similar in both groups. There was no significant association between WHR and lipid parameters except TG in males (Table 3). There were significant associations between current smoking with TG (p=0.000), LDL/HDL (p=0.050), TC/HDL (p=0.007) and TG/HDL (p=0.000). Also, those who were consuming alcohol had significantly elevated TG (p=0.034), LDL/HDL (p=0.019), TC/HDL (p=0.008) and TG/HDL (p=0.002).

DISCUSSION

Obesity is one of the major health problems worldwide. Obese subjects have been identified with a higher risk of altered or atherogenic lipid profile which leads to CVD and metabolic syndrome. The prevalence of obesity increases with westernized food pattern, sedentary life styles, physical inactivity and smoking. Further, incidence of overweight and obesity is steadily increasing in the urban settings of low and middle income countries including majority of the Asian countries. The prevalence is high in South East Asian region due to economic growth affluence, urbanization and dietary westernization (Misra *et al*., 2007). Present study also adds to the above findings, where working young adult with good education, higher monthly income and urban area residences were higher in the study population (Table 1) and the percentage of overweight and obesity were also high (Table 2). National level studies conducted among Sri Lankan adults had found a positive association for lipid profile with smoking (Katulanda *et al*., 2011) and consumption of alcohol (Karunaratne *et al*., 2008) in males (38%, 46.9%) and females (0.1%, 22.3%). Percentages of subjects who were present smokers and consume regular alcohol were comparatively low in this study population. Further these behaviours were only observed in the male population (Table 1). In the present study mean BMI was 23.8 (± 4.0 SD) kgm^{-2} for the total study population, 23.8 (± 3.5SD) kgm^{-2} in males and 23.7(±4.4) kgm^{-2} in females which were comparatively higher indicating, that tendency to be obese is increasing. In addition, percentage of subjects with obesity (36.1%) was higher than the normal BMI group (31.9%) in this study population. A national level study carried out in Sri Lanka which was published in 2010 had shown that mean BMI was 21.1kgm^{-2} (20.9 – 21.3 kgm^{-2}) and the prevalence of obesity was 9.2 % (Katulanda *et al*., 2010). Another study conducted among a young urban population in Colombo district which was published in 2011 had shown that mean BMI for males was 22.8 kg/m^2 (22.3-23.4 kg/m^2) and 22.0 kg/m^2 (21.3 – 22.7 kg/m^2) in females (Wijesuriya *et al*., 2011). Hence when comparing these data the mean value for BMI has been increasing from 2010 to the present value; suggesting an increase occurrence of obesity. Although the study populations were different in the three study settings there is an increase in the prevalence of obesity within the community. Even though this study was conducted in apparently healthy volunteers who were non-diabetic and non-hypertensive, there is a risk of dyslipidaemia in the obese group when compared to the normal BMI population. In addition most of the lipid parameters were significantly elevated in the obese group except HDL-C. In addition all the lipid parameters increased with an increase in BMI whereas HDL-C decreased with an increase in BMI.

There were significant correlations and associations between lipid parameters, BMI and WHR in males. But there weren't any significant correlations or associations between lipid parameters and WHR in females. An elevated level of lipid parameters in non-obese females indicates the necessity for a screening program in all adults. According to the WHO recommended cut off values proposed for South East Asians

most obese subjects (according to BMI) were females, but they had normal or non-risk WHR in this study population even though WHR is neither area specific nor ethnic specific. A study conducted in Indonesia indicated that there is no significant correlation between the lipid parameters and WHR in adult females. But, there were significant correlations with the percentage of body fat, LDL, TC and TG (Darmawan and Irfanuddin, 2007). Fat distribution and the risk associated with it may vary in different populations. Some populations are more prone to get obesity associated co-morbidities even at lower levels of obesity than the globally recommended cut-off values (Mishra *et al*., 2012). Therefore cut off values recommended by the WHO may not suit best for the adult Sri Lankan female population. The mean values of all the lipid parameters except HDL were higher in obese population and males with high WHR when compared to the whole study population. HDL had a significant negative correlation and association with BMI and WHR in male population. The significant reduction in HDL among obese population could be attributed to less physical activity and sedentary life styles which may ultimately contribute to the development of CVD in this population.

Studies have indicated that behavioural factors such as, smoking and consumption of alcohol contribute to obesity and dyslipidaemia. Even though the number of smokers and alcohol consumers were very low in this study population there was a significant association between lipid parameters and smoking among the smokers. In addition most of them were obese. Obesity related symptoms appear only at a later stage and many people are unaware that obesity alone could lead to an altered lipid profile. Therefore, behavioural modification may have an effect in reducing the risk of getting obese and dyslipidaemia and ultimately CVD in future. Hence this study contributes to the finding that the percentage of overweight and obesity is increasing in Sri Lanka. In addition though the study population was apparently normal healthy population, the percentage of obese subjects with altered lipid profile was higher indicating the necessity for an effective screening process. Hence paying attention to this emerging problem and creating awareness of the harmful effects will be of health importance in order to reduce the risk of CVD and premature deaths in all Asian population.

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Conflict of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Ethical approval

"All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards." "This article does not contain any studies with animals performed by any of the authors".

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