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BRIEF REPORT

BODY FAT AND LIPID PARAMETERS OF MANAGEMENT ASSISTANTS IN A RURAL AREA IN SRI LANKA

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Abstract

Background

Fat in certain body compartments has a significant contribution to dyslipidemia.

Objective

The objective was to determine the fat distribution in various body compartments among management assistants (clerks: sedentary occupational group), from the Anuradhapura Municipal Council area, Sri Lanka and to estimate their lipid profiles for any correlation with fat distribution.

Methods

In this descriptive cross-sectional study [n=78; males=15(mean age=38(11) years); females=63 (mean age=39(9) years)], weight, height, waist and hip circumferences were measured using standard WHO methods. Body fat was measured using 8 electrode bio impedance analyzer system (HBF375 Karada Scan, Japan). Lipid profile was estimated using colorimetric assay kit methods.

Results

According to the BMI, 57% of females were obese and 13% were overweight, and 67% of males were obese and 20% were overweight. Abdominal obesity [WC>90cm males; >80cm females] was present in 73% of males and 81% of females. Based on total BF% (males>25%; females>35%-obese), 73% males and 65% females were obese. Twenty nine percent of females and 73% of males had a high visceral fat percentage (>10%).

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Among the females, 68%, 17%, 92% and among males, 73%, 27%, 80% had hypercholesterolaemia, hypertriglyceridemia and high LDL levels, respectively. Low HDL levels were observed in 47% of males and 68% of females. Conicity index (CI) and body adiposity index (BAI) were at high risk level in 93% of males and 75% of females and 27% of males and 56% of females, respectively.

Conclusion

The prevalence of overweight and obesity was high among the individuals of the study group and a majority were unaware that they were dyslipidemic.

Key words: body fat, overweight, management assistants, visceral fat, hypercholesterolaemia

Introduction

Contribution of fat depots in the body on NCDs

The incidence of overweight and obesity among Sri Lankans are reported to be 25.2% and 9.2% respectively[1]. Obesity and overweight are mainly instigated by excess body fat (BF) deposition. Overweight and obesity due to high body fat is associated with many metabolic disorders including diabetes mellitus, hypertension and cardiovascular diseases (CVD)[2]. Dyslipidemia which leads to many of the non-communicable diseases (NCDs) in obesity and overweight is mainly due to circulating free fatty acid (FFA) levels which act upon muscles, pancreatic beta cells and vascular endothelium. In obesity or overweight, there is a failure in regulation of FFA release in response to insulin/ meal ingestion. This can be explained by understanding the metabolic activity of different fat depots in the human body[3].

If the body fat depots are categorized as upper subcutaneous (USC), lower subcutaneous (LSC) and visceral, most dietary fat is deposited in visceral, than in USC and LSC depots respectively per gram of tissue[4]. Therefore, during lipolysis, visceral fat releases more FFAs per gram of tissue[5]. During overnight post absorptive stage, USC fat depot undergoes more lipolysis compared to LSC. Therefore, in the post absorptive stage, USC fat has a greater contribution to circulating fatty acids[3].

During the fed state, the action of insulin on suppression of fatty acid release is more in LSC than USC depot. Thus, even in the fed state, release of fatty acids is comparatively higher in the USC depot than LSC. However, as the large adipocytes in visceral fat are resistant to insulin, the highest amount of fatty acids are released by the visceral depots during the fed state[3]. Moreover, visceral depots release more harmful cytokines and decrease the release of beneficial adipokines. FFAs and cytokines released from visceral depots are taken up by the liver and are responsible for making lipoproteins, increasing VLDL and LDL in the circulation[3].

Recent research reveal that more than 60% of the post prandial circulatory fatty acids are from USC and not from visceral depots[6]. Although the actions and efficacy of lipolysis in USC and visceral depots is still under debate, it is proven that both these depots are responsible in atherogenicity, USC by increasing circulatory fatty acids (leading to obesity) and visceral by uploading visceral (omental) fatty acids and cytokines to liver (leading to atherogenicity). Therefore, estimation of percentage fat depots in USC and visceral compartments is beneficial during screening and preventive measures of NCDs.

High risk of NCDs in South Asians

When the whole body is considered according to the three compartment basis, body fat depots can again be divided in to superficial subcutaneous, deep subcutaneous and visceral, which have different metabolic activity rates. Therefore, studies have emphasized the importance of considering regional body fat distribution than excess adiposity or BMI in evaluating the risk of CVD and other metabolic disorders[7]. In Caucasians, excess dietary energy is deposited in the superficial subcutaneous compartment (all over the body) as fat which is metabolically inactive. The superficial subcutaneous compartment of South Asians is smaller compared to Caucasians. Hence, excess energy is mainly deposited in the deep subcutaneous and visceral compartments as fat in South Asians. These compartments contain metabolically active adipose tissues and this leads to the release of free fatty acids and other lipid derivatives to the blood stream making dyslipidemic effects[2] thus could influence the lipid profile. Despite having lower body fat percentages and lower BMI compared to Caucasians, higher incidence of NCDs among South Asian populations could be explained by the above outcome.

Conversely, obesity strongly depends on the dietary patterns and the level of physical activities of individuals[8]. Nature of the different occupational categories determines the physical activity rates and thereby the body composition and health status of the workers. Body fat distribution of working populations, changes in lipid profile with body fat distribution and associated risks are yet to be researched in Sri Lanka.

NCD risk in Anuradhapura – a rural area in Sri Lanka

According to a survey conducted in 2011, the prevalence of diabetes in the North Central province, a rural area of Sri Lanka was 9.6%. Compared to another rural area (Uva province – 6.8%) which had a comparable mean energy consumption of the population, diabetes prevalence was higher in the North Central province[9]. Anuradhapura is the capital of this province and it is currently experiencing drastic changes in human lifestyles, shifting from an agricultural environment towards a sedentary framework. As the changes in lifestyle, dietary patterns and physical activity could worsen the burden of metabolic syndrome even in rural areas in Sri Lanka, people should be educated regarding the prevention of NCDs via increasing physical activities.

“Management assistants” who basically engage in clerical work is an occupational group categorized under sedentary physical activity[10]. The objective of the present study was to determine the body fat distribution in various compartments of the bodies of management assistants (clerical staff) working in government sector institutions of the Anuradhapura municipal council area.

Materials and methods

The study was a descriptive cross sectional study [n=78; males=15 (mean age = 38(11) years; females=63; mean age=39(9) years]. All management assistants working in the government sector offices in Anuradhapura municipal council area who volunteered to participate in this study were recruited after obtaining written consent. Ethical approval was obtained from the Ethics Review Committee of the Rajarata University of Sri Lanka (Approval No. ERC/2016/10).

Anthropometric data

Height and weight of the individuals were measured using a standardized stadiometer and a calibrated electronic scale with digital readout to the nearest 0.1 kg respectively. BMI was calculated by the individuals' body weight (kg) divided by height (m) squared (kg/m^2).

Waist circumference (WC) was measured at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest using a non-stretchable tape and hip circumference was measured at the widest portion of the buttocks[11].

Body fat analysis

Body impedance was measured by a pre validated single-frequency, 8 electrode bio impedance analyzer system (HBF 375 Karada Scan, Japan)[12, 13]. Results were compared with a standard equation derived through DXA method for body fat percentage analyzing[14]. Cutoff of total body fat for males and females were considered as 25% and 35% respectively[15]. Lipid profile was estimated using colorimetric assay kit methods (BIOLABO, France).

Cutoff values considered for the parameters in the present study are shown in table 1.

Data analysis

Data were analyzed using SPSS version 18 for Windows and Microsoft Excel 2007. Data were interpreted as percentages, and the significant differences between males and female groups were estimated at 95% confident interval. Correlations between parameters were determined by Pearsons' correlation coefficients.

Results

Socio demographic data and anthropometric data

The study population included management assistants with no diagnosed NCDs (n=78), aged 20-60 years who were employed in the Anuradhapura municipal council area. Mean weight, height, waist circumference, hip circumference and waist: hip ratios of the population are shown in table 2.

According to the BMI, in the female population 57% (36/62) were obese and 13% (8/63) were overweight and in the male population 67% (10/15) were obese and 20% (3/15) were overweight. Abdominal obesity [abdominal obesity: WC >90 cm males; >80 cm females] was present in 73% of males and 81% of females. Based on the W:H ratio 70% of females were at a high risk and 24% of females and 40% of males were at a moderate risk for CVD (W:H = 0.96 – 1.0 for males; 0.81 – 0.85 for females – moderate risk; >1.1 for males; >0.86 for females – high risk).

Body fat analysis

Percentage BF values obtained by bio impedance analyzer system (HBF 375 Karada Scan, Japan) showed a strong positive correlation (r=0.87, p< 0.00001) with the values obtained by the equation derived for Asian men and women, via DXA method. Fat and skeletal muscle percentages in different compartments of males and females are shown in table 3.

Based on total BF% (males >25%; females >35% - obese), 73% males (11/15) and 65% females (41/63) were obese. Twenty nine percent of the females and 73% of the males had a high visceral fat percentage (>10%). Skeletal muscle percentages in all compartments were higher in males than females. However, fat depots percentages

Table 1: Cutoff values

Parameter	Normal	Risk category		
FBS [24]	<100 mg/dl – normal; 101 - 126 mg/dl (7.0 mmol/l) – pre diabetic	≥126 mg/dl (7.0 mmol/l) - DM	-	-
Total cholesterol [25]	<150 mg/dl	low risk (150-200 mg/dl)	between 200-239 mg/dl - borderline high risk	> 240 mg/dl - twice the high risk
Triglycerides [25]	<150 mg/dl-normal	150-199 mg/dL-Border line	200-499 mg/dl-H	500 mg/dl and above-VH
LDL [25]	<100 mg/dl	>100 mg/dl	-	-
HDL [25]	60 mg/dl and above-best	40-49 M, 50-59 F – low risk	< 40- M , < 50-F high risk	-
Atherogenic index (AI)	<0.21	≥0.21		
BAI [26]	<34.6%	≥34.6%		
CI [27]	<1.25	≥1.25		

Parameter	Risk level		
BMI[28]	<23 - normal	23<25 – over weight	>25 - obese
Waist [11]	<90 cm for males; <80 cm for females - normal	>85 cm for females; >90 cm for males – high risk	-
Waist:hip ratio [29]	<0.95 for males; <0.80 for females – low risk	0.96 – 1.0 for males; 0.81 – 0.85 for females – moderate risk	>1.1 for males; >0.86 for females – high risk

FBS = fasting blood glucose; HDL=high density lipoprotein cholesterol; LDL= low density lipoprotein cholesterol; AI= atherogenic index; CI=conicity index; BAI= body adipocity index; BMI= body mass index
WHO and IDF, 2006[24]
Palo Alto Medical Foundation: South Asians and Cholesterol[25]
Gadelha *et al*., 2016 [26]
Nadeem *et al*., 2013 [27]
The Asia-Pacific perspective: Redefining obesity and its treatment, 2000 [28]
report of a WHO expert consultation, 2008 [11]
Qiao and Nyamdorj, 2010 [29]

were higher in females compared to males. The highest fat percentage in females was in the arms [49(4.3)] followed by legs [44(5.6)], while males had comparable fat percentages in both arms and legs. The mean visceral fat percentage of males was 5% higher than in females (table 4).

Subcutaneous fat in the whole body, trunk, legs, arms and total body fat (TBF) was higher in females, and fat in all the compartments increased with increasing age, with a significant rise from the 30s to 40s (table 4 and figure 1). However, visceral fat in males was higher than that of females and increased with age, with

Table 2: Mean weight, height, waist circumference, hip circumference and waist: hip ratios

	Males (n=15)	Females (n=62)
Mean age in years	38(11)	39(9)
Mean weight	76(11) kg	60(10) kg
Mean height	168(6) cm	155(6) cm
Mean BMI	27.0(4)	25.6(4)
Mean waist circumference	97(12) cm	89(9) cm
Mean hip circumference	104(7) cm	102(8) cm
Mean waist: hip ratio	0.93(0.07)	0.90(0.04)

Table 3: Fat % and skeletal muscle% in different compartments of males and females

	Males (n=15)		**Females (n=63)**	
	SC	***SK***	***SC***	***SK***
Whole body	19.5(3.5)	30(2.6)	30.9(4.4)	22.8(1.9)
Trunk	18(3.6)	22(3.3)	27.7(4.2)	17.4(2.2)
Leg	27(4.9)	47(2.6)	44.3(5.6)	35.0(1.9)
Arm	27(4.5)	36(2.5)	49.3(4.7)	23.7(3.4)
%TBF	28(4.6)		36.4(4.0)	
BMR	1675(165)		1258(1328	
Visceral Fat	13(5.5)		8(3.8)	

SC- subcutaneous; SK- skeletal muscle; BMR- basal metabolic rate; TBF = Total body fat

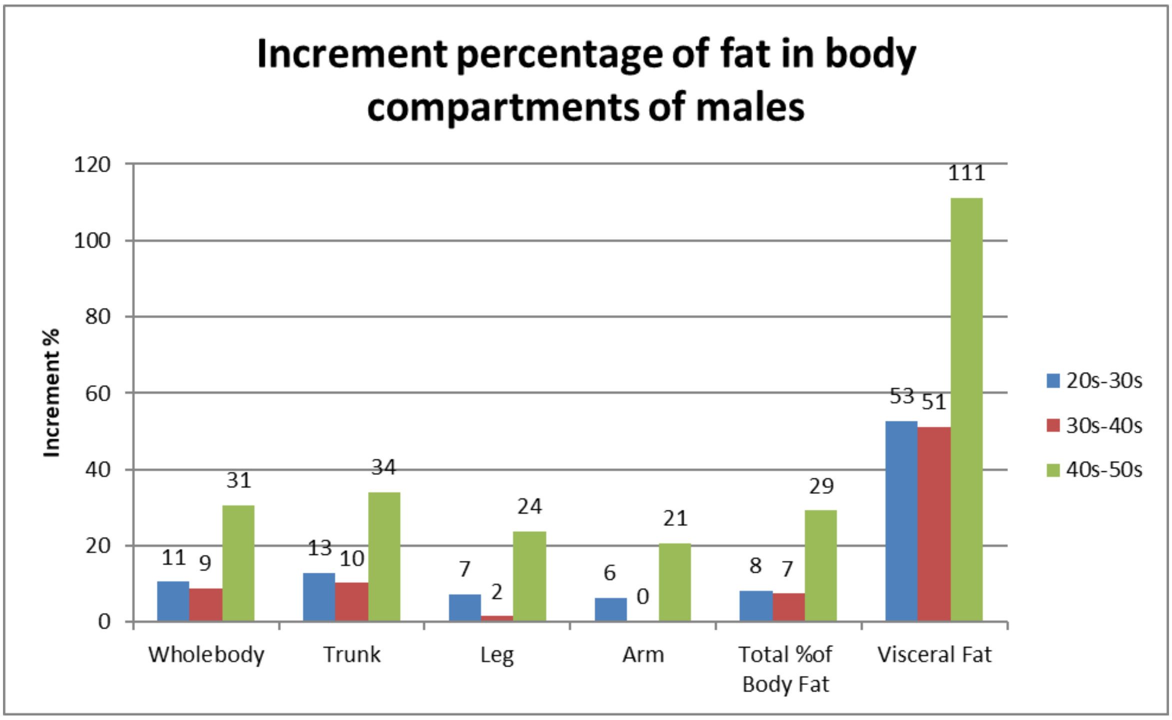
Table 4: Fat depot percentages in different age groups

Gender	Age	Whole body	Trunk	Leg	Arm	Total % of Body Fat	Visceral Fat
Female	20s	28	24	41	46	33	5
	30s	30	27	43	48	35	7
	40s	33	30	47	51	38	10
	50s	32	30	47	53	40	10
Male	20s	18	16	26	26	26	9
	30s	20	18	28	28	28	14
	40s	19	18	26	26	28	14
	50s	23	21	32	31	33	19

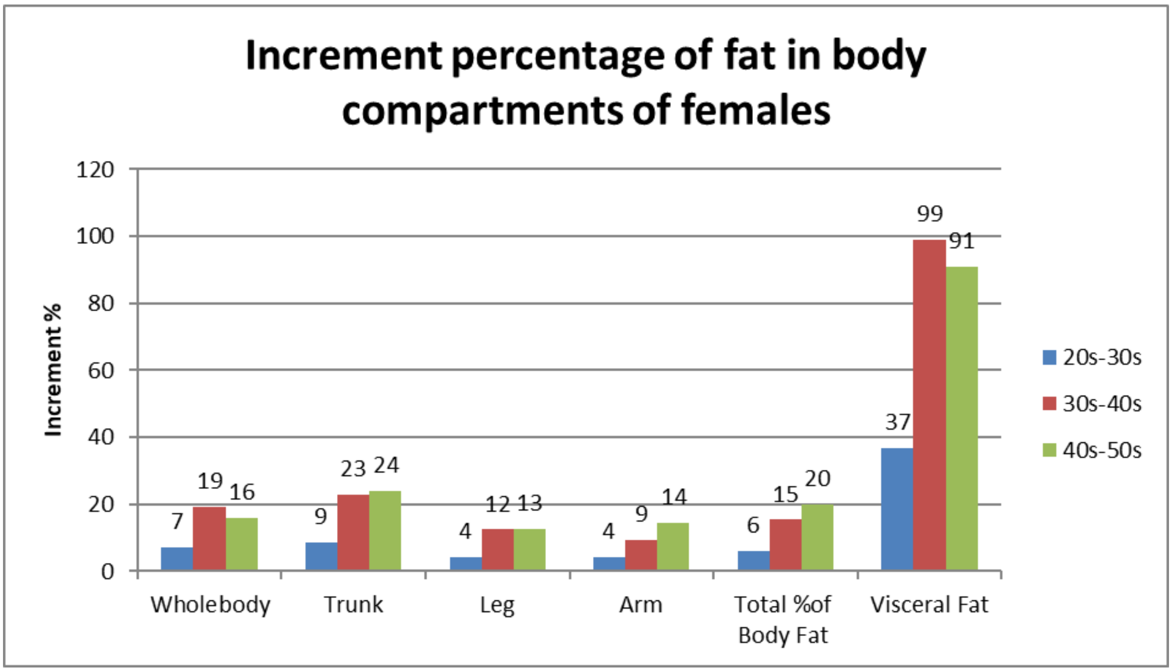
to 50s, emphasizing the rapid rise of visceral fat depots with increasing age in males. Compared to the other compartments, the highest fat depot increment was observed from 30s to 40s with a total body fat increment percentage of 8.7% (figure 1).

Four out of 63 and 2/63 of females were not aware that they were having hyperglycemia and pre diabetes.

Of the females, 68%, 17%, 92%, and among the males, 73%, 27%, 80% had hypercholesterolaemia, hypertriglyceri-



(A)



(B)

Figure 1 (A) Increment percentages of fat in body compartments of males from 20s to 30s, 30s to 40s and 40s to 50s; (B) Increment percentages of fat in body compartments of females from 20s to 30s, 30s to 40s and 40s to 50s

demia and high LDL levels, respectively. Low HDL levels were observed in 47% of males and 68% of females. The atherogenic index was in the high risk level for 62% of females and 80% of males.

Table 5: Mean serum lipid parameters

	Males (n=15)	Females (n=63)
FBS	97(40) mg/dl	84(28) mg/dl
Total cholesterol	234(76) mg/dl	245(67) mg/dl
TAG	122(47) mg/dl	103(53) mg/dl
HDL	41(8) mg/dl	45(11) mg/dl
LDL cal	169(73) mg/dl	179(63) mg/dl
AI	0.46(0.19)	0.31(0.28)
CI	1.32(0.07)	1.32(0.11)
BAI	29.70(4.37)	35.38(5.39)

FBS = fasting blood glucose; TAG=triacylglycerol; HDL=high density lipoprotein cholesterol; LDL (cal)= calculated value of low density lipoprotein cholesterol; AI= atherogenic index; CI=conicity index; BIA= body adipocity index

Table 6: Correlations between anthropometric parameters and lipid parameters

	TAG	HDL	AI	CI	BAI
WC	*0.33 (p= 0.0032)	**-0.46 (p<0.0001)	**0.43 (p<0.0001)	***0.60 (p<0.0001)	**0.55 (p<0.0001)
W:H	*0.32 (p=0.0043)	*-0.34 (p=0.0023)	**0.40 (p=0.00028)	**0.46 (p<0.0001)	
Whole body SC	-	-	-	*0.24 (p=0.034307)	****0.82 (p<0.0001)
Trunk SC	-	-	-	*0.28 (p=0.013034)	****0.85 (p<0.0001)
Leg SC	-	-	-	-	****0.80 (p<0.0001)
Arm SC	-	-	-	-	***0.69 (p<0.0001)
TBF	-	-	-	*0.31 (p=0.0057)	****0.81 (p=0.0057)
BMI	-	**-0.41 (p=0.000193)	*0.31 (p=0.0057)	*0.38 (p=0.0006)	***0.70 (p=0.0057)
Visceral fat	-	*-0.37 (p=0.0008)	*0.32 (p=0.0043)	*0.37 (p=0.0008)	**0.52 (p<0.0001)

*weak correlation; **moderate correlation; ***strong correlation; ****very strong correlation
SC=subcutaneous; WC=waist circumference; W:H=waist: hip ratio; TBF=total body fat; BMI=body mass index AI, CI, BAI

The conicity index and body adiposity index were at high risk level in 93% of males and 75% of females and 27% of males and 56% of females, respectively.

Among the females with hypercholesterolemia (43), 26 were in the ages of 20s and 30s (66.6% of females were in their 20s and 30s). Among the males with hypercholesterolemia (11), 4 were in the ages of 20s and 30s.

Correlations

Correlations between parameters are shown in table 6.

Waist circumference had a moderate negative correlation with HDL and moderate positive correlations with AI and BAI and a strong correlation with CI. BAI had very strong correlations with whole body SC, trunk SC and total body fat, strong correlations with arm SC and BMI and moderate correlation with visceral fat. Visceral fat had weak positive correlations with AI and CI, weak negative correlation with HDL and a moderate positive correlation with BAI.

Discussion

The present study reveals that a considerable number in this population is at a high risk for NCDs and many are not aware that they have a high BMI, dyslipidaemia or diabetes. Both males and females should to pay more attention to body fat deposition and alterations of serum parameters related to NCDs, in their 20s and 30s, as there is a radical increase in body fat deposition during this age, which reaches a plateau in the 40s and 50s.

As the literature indicates, this age related body fat changes could be due to the decrease in lower body fat and increase in visceral fat which has been observed in the present study as well. Some studies elucidate that the age related fat percentage changes could be due to a decrease in lean mass and bone minerals, despite body fat increase with age. Therefore, some researchers emphasize that the total percentage body fat increase could be due to the decrease in lean mass with age. However, the percentage abdominal fat increase could be due to excess fat deposition in the abdominal region[15]. Furthermore, the risk of NCDs increases with age due to fat deposition in the heart, liver and skeletal muscles, making these organs resistant to insulin. Moreover, there are reductions in the mass of individual organs/tissues with increasing age and thus in tissue-specific organ metabolic rate. This could be responsible in decreasing overall resting metabolic rate, which will also increase the fat mass and reduce fat-free mass[16].

A considerable number of individuals in the present study were unaware that they were dyslipidemic or prediabetic or diabetic. A study conducted in the North Central province in 2016 (n=24) with a non diabetic population revealed that hypercholesterolemia, hypertriglyceridemia, reduced HDL levels and increased LDL levels were present in 37.5%, 42.0%, 16.7%, 41.7% of individuals whose BF% were ≥ 30%, respectively[17]. In the present study, 68%, 17%, 92% of females and 73%, 27%, 80% of males had hypercholesterolaemia, hypertriglyceridemia and high LDL levels, respectively. Low HDL levels were observed in 47% males and 68% in females. Except for the percentage of population with hypertriglyceridemia, all percentages with other dyslipidemic conditions were higher than the study conducted in 2016. This could be due to the higher sample size of the present study. This indicates a large number of "healthy" individuals in Sri Lanka are unaware that they are having NCDs and this might become a considerable burden in the near future, weighing down on the country's economy.

A visceral fat rate ≥ 7, total body fat above 34% and WC above 88 cm are risk factors for metabolic syndrome in women[18]. Half (50.8%) of the females (32/63) of the present study were at or exceeding these risk levels.

In the present study, visceral fat had weak positive correlations with AI and CI, a weak negative correlation with HDL and a moderate positive correlation with BAI. This indicates that compared to fat depots in other compartments of the body, visceral fat causes a significant contribution to the lipid profile, mainly affecting HDL levels. This is further proven by the correlations elicited by the WC (a moderate predictor of visceral fat[19]) with TAG, HDL, AI, CI and BAI.

When the whole population of the current study is considered, the mean fat percentages obtained for different body compartments [trunk 25.8(5.7)%; legs 41.0(8.7)%; arms 45.0(10.0)%] were considerably higher than the values obtained in a similar study in India conducted using a BIA -Omron Karada Scan (Model HBF -510, Japan), which elicited the fat percentage of the trunk, legs and arms to be 22.9 ±6.9%, 27.9 ±8.1% and 29.0 ±9.2% respectively[20]. Another study conducted to measure BF of South Asians by Foot to Foot BIA method and BOD POD method (n=80), obtained results of 21.94±7.88% and 26.20±8.47%, BF respectively by the two methods. The mean age of that population was 27.78±10.49 years, (42.5% were women) and the mean BMI was $22.68 \pm 3.51\ kg\ m^{-2}$ [21]. The BF% of the group with a mean age of 26.8(2.7) years [BMI=24.9(4.1)] in the present study (n=63) had 29.5(5.1)% mean BF. Therefore, the above outcomes indicate that the population of the present study, mainly the female population, had higher body fat values and had more NCD risk factors compared to the other South Asian populations.

A study conducted in Sri Lanka in 2013 with a BC 418, Tanita, Japan BIA, revealed that the BF% of men (age 26.7 ± 6.6years) was 19.5 ±6.6 and females was 28.0 ± 6.0 and 34.7 ± 4.3 (when the age groups were 25.9 ± 7.2 years and 47.3 ± 4.9 years, respectively)[22]. The total BF% of males in the present study was 17.7(3.9) (age 20s) and that of females was 28.0(3.7) (age 20s) and 33.3(2.7) (age 40s) which were comparable to the previous study. A Sri Lankan healthy population (n=100) with a mean age of 37.4 ± 3.5 years, BMI 23.9 ± 4.1 described a 37.2 ± 5.2 mean fat mass % when fat mass was determined by ^2H_2O dilution technique for body composition analysis. In the present study, for the same age group of women, comparable results were obtained [mean age 34.2(3), BMI 24.9(4.1), BF% 35.2(3.9)]. Furthermore, that study elucidated that the fat mass percentages calculated by applying Density (obtained by Durnin and Womersley equation) to Siri and Brozek*et al* equations and to the equation developed by de Lanerolle-Dias *et al*. significantly ($p < 0.001$) underestimated %FM compared to the ^2H2O dilution[23].

Conclusion

The incidence of overweight and obesity and high fat percentages in various body compartments were higher among females compared to males in the tested population and higher than the values obtained for the same parameters in prior studies with international populations. A considerable number of the population is not aware that they are dyslipidemic, diabetic or overweight. This indicates that standardization of the body fat percentage values and establishment of cutoff values for Sri Lankans and awareness programmes are mandatory to minimize the risk of developing non communicable diseases.

List of Abbreviations

BF – Body fat
WC – waist circumference
HDL – High density lipoprotein cholesterol
LDL – Low density lipoprotein cholesterol
CI – Conicity index
BAI – Body adiposity index
CVD – Cardio vascular diseases
NCD – Non communicable diseases
FFA – Free fatty acids
USC – Upper subcutaneous
LSC – Lower subcutaneous
BMI – Body mass index
TAG - Triacylglycerol
BIA – Body impedance analyzer

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