GENDER DIFFERENCES OF BIO-IMPEDANCE ANALYSIS, SOMATOTYPING AND SELECTED ANTHROPOMETRIC MARKERS OF ADIPOSITY AND THE ASSOCIATION WITH INSULIN RESISTANCE IN HEALTHY MALE AND FEMALE POPULATION IN SRI LANKA

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Introduction

There is a well established difference of body composition between males and females for a given body mass index [1]. The lean mass is significantly higher in males compared to females and adiposity is higher in females compared to males [1]. Furthermore, males generally show more central obesity, while femlaes show more peripheral fat distribution [1]. When the fat distribution is considered, males show a high level of visceral adiposity compared to subcutaneous fat distribution.

Bio impedance analysis (BIA) is a simple technique which is used to assess the body fat level. This technique is based on the principle of resistance which is generated against an electrical current which passes through the human body. Reference methods of measurement of lean body mass, adiposity, visceral fat levels and subcutaneous fat levels require advanced and expensive techniqes like Magnetic Resonance Imaging, Hydrodensitometry which are not practical to be used in a normal laboratory and a clinical setup. When the measurement of body composition is considered, anthropometry is a feasible and a practical method to be used in clinical practice. For the measurement of adiposity, the most commonly used indicator is Body Mass Index (BMI). Other than that, there are different formulae developed for the calculation of body fat percentage using anthropometric measurements.

However, when assessing the risk with regard to the development of non-communicable diseases, the lean body mass is not considered as a risk marker. There is no anthropmetric index which can be used to represent lean mass. "Mesomorphy" which is a component of somatotytping may have a place to be used as an indicator of lean body mass.

"Somatotyping" is another method of body composition assessment and the final measurement is given as a somatotype. "A somatotype is a description of the present morphological conformation which is expressed in a three numeral rating, consisting of three sequential numbers, always recorded in the same manner. Each numeral represents the evaluation of three primary components of physique which describe individual variations in human morphology and composition"[2]. This concept was originally described to classify the human physique by Sheldon et al in 1940 and was modified by Heath and Carter in 1967 [2].

Three components where numeral ratings were given in somatotyping are Endomorphy (relative fatness in individual physique), Mesomorphy (relative musculoskeletal development pre unit of height (lean body mass relative to the height) and Ectomorphy (relative linearity based on height/cube root of weight ratios/evaluate the form and degree of longitudinal distribution of the first and second components) [3].

The objectives of the current study were to compare the markers of body composition measured by anthropometric methods, Bio-impedance analysis, and somatotyping by gender and determine the association of the measurements obtained from above methods with insulin resistance in a selected population.

Materials and Methods

Apparently healthy 54 females and 46 males without a history of Type 2 diabetes mellitus or other non-communicable diseases, living in the Elehera divisional secretariat area in Polonnaruwa district and subjects attending the Family Practice Centre, University of Sri Jayewardenepura were recruited for the study. Ethical approval for the study was obtained from the Ethics Review Comitte, Facutly of Medical Sciences, University of Sri Jayewardenenpura.

Biochemical analysis

Ten hour fasting blood samples were collected for the assessment of Insulin Resistance (IR) of the population. Fasting Blood Glucsoe (FBS) level was assessed using Glucose Oxidase method. Serum insulin level was assesd using ELISA technique.

Insulin resistance was calculated using HOMA-IR equation (homeostatic model assessment).

HOMA-IR = [fasting plasma insulin (mu/ml)*fasting blood sugar (mmol/l)]/22.5

HOMA-IR values $\geq$2.6 were considered as insulin resistant based on the findings of a research done locally by Palangasinghe [4].

Assessment of body composition

Anthropometric measurements were taken to evaluate the body fat distribution. Waist circumference (WC), waist-to-hip ratio (WHR), waist-to-thigh ratio (WTR) and body mass index (BMI) were used as measures of adiposity.

Body fat percentage (BF%), sub-cutaneous fat percentage (SCF%) and skeletal muscle percentage (SM%) were assessed using bio-impedance analyser.

The somatotypes were calculated using the “anthropometric method” following the Heath-Carter anthropometric somatotype instruction manual. Triceps, subscapular, supra-spinal skinfolds were taken to calculate the endomorphy [Endomorphy = - 0.7182 + 0.1451 (X) - 0.00068 (X^2) + 0.0000014 (X^3); X =]. Humerus breadth, femur breadth, arm girth, calf girth and calf skinfolds were measured to calculate mesomorphy [mesomorphy= 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm girth + 0.161 x corrected calf girth – height 0.131 + 4.5]. Height and weight measurements were taken to calculate the ectomorphy. Ectomorphy was calculated by different equations depending on the height to weight ratio (HWR) [(If HWR $\geq$ 40.75, ectomorphy = 0.732 HWR - 28.58) (If 40.75 > HWR < 38.25 then, ectomorphy = 0.463 HWR - 17.63) (If HWR $\leq$ 38.25 then, ectomorphy = 0.1)].

Statistical analysis

Statistical analysis was performed in two stages. First, the measured parameters were compared between females and males. Then both female and male populations were devided in to four groups based on their insulin resistance (as insulin resistant and non-insulin resistant) and differences were assessed in female and male groups separately. The significant differences of the mean parameters of the two groups were analysed using the student t-test. When the distribution of the variables was not normal in at least one of the compared groups, Mann-Whitney U-test was applied. P values of <0.05 were considered as significant.

Results and Discussion

Mean age of females was 40 years while that of males was 44 years. Thirty one percent of the study population reported a family history of T2DM.

BMI, BF%, SCF% and endomorphy were significantly higher among females. On the other hand WHR, WTR, skeletal muscle percentage and ectomorphy were significantly higher among males (Table 01).

Table1. Distribution of assessed variables among female and male subjects

Variable	Female (SD)	Male (SD)	P
Waist circumference	83.06 (±9.16)	84.83 (±8.71)	0.325
BMI	24.79 (±4.35)	23.04 (±3.35)	0.042
Waist-to-hip ratio	0.86 (±0.06)	0.90 (±0.04)	0.000
Waist-to-thigh ratio	1.83 (±0.29)	1.97 (±0.71)	0.005
Body fat %	34.36 (±4.56)	24.27 (±4.55)	0.000
Whole body subcutaneus fat %	29.59 (±5.14)	19.73 (±20.95)	0.000
Whole body skeletal muscle %	23.52 (±2.26)	30.73 (±2.30)	0.000
visceral fat level	7.41 (±4.68)	8.33 (±3.97)	0.160
Endomorphy	6.21 (±1.29)	4.29 (±1.46)	0.000
Mesomorphy	4.90 (±1.71)	4.48 (±1.31)	0.180
Ectomorphy	1.18 (±1.20)	2.23 (±1.34)	0.000
Fasting blood sugar (mg/dl)	86.62 (±15.21)	85.24 (±8.24)	0.530
fasting insulin level	11.68 (±4.36)	11.63 (±6.66)	0.369
insulin resistance	2.58 (±1.55)	2.45 (±1.40)	0.609

When the male and female populations were divided in to groups based on the IR values there were 19 insulin resistant female subjects, 10 insulin resistant male subjects, 35 non-insulin resistant female subjects and 36 non-insulin resistant male subjects.

Insulin resistant female population showed significantly higher values in WC, BMI, BF%, subcutaneous fat percentage, viscerla fat leves and endomophy, compared to the non–IR female group. On the other hand, non-insulin resistant female group showed significantly higher values in skeletal muscle percentage, mesomorphy and ectomorphy.

When the male population is considered, IR group showed significantly higher WTR, subsutanoeus fat percetnages and endomorphy compared to the non-IR group.

Conclusions and Recommendations

Results of the current study show that males have a significant central fat distribution while femlaes have a significant peripheral fat distribution. However, when insulin resistance is considered, both markers of central and peripheral fat distribution showed applicability as valuable risk evaluation markers among females. On the other hand, somatyping also demonstrateted it's potential as a valuable metabolic risk indicator especially in females.

Since males did not show a significant association with asesesed risk indictors, futher studies should be carried out with a larger sample to test whether either indicators of central fat distribution or peripheral fat distribution are better for risk evaluation in males, especially the somatotyping technique, since somatotyping parameters showed significant differences between the IR and non-IR females.

Table 2. Distribution of assessed variables among female and male subjects based on insulin resistance

Varible	Female			Male		
	Non-IR (SD)	IR (SD)	P value	Non-IR (SD)	IR (SD)	P value
WC	81.13 ± 8.70	86.60 ± 9.15	0.040	83.69 ± 7.16	88.94 ± 12.48	0.064
BMI	23.38 ± 3.55	27.38 ± 4.58	0.002	22.66 ± 3.11	24.45 ± 3.94	0.230
WHR	0.85 ± 0.07	0.86 ± 0.05	0.673	0.90 ± 0.03	0.92 ± 0.06	0.091
WTR	1.81 ± 0.22	1.86 ± 0.38	0.625	1.85 ± 0.17	2.42 ± 1.45	0.043
Body fat %	33.37 ± 4.23	36.17 ± 4.72	0.038	23.86 ± 4.77	25.72 ± 3.52	0.149
subcutaneus fat %	28.07 ± 4.51	32.38 ± 5.15	0.004	16.38 ± 4.44	31.77 ± 43.72	0.017
Skeletal muscle %	24.01 ± 2.15	22.60 ± 2.22	0.003	30.97 ± 2.16	29.84 ± 2.71	0.149
visceral fat level	6.11 ± 3.39	9.79 ± 5.80	0.018	7.81 ± 3.62	10.20 ± 4.78	0.108
Endomorphy	5.89 ± 1.21	6.81 ± 1.22	0.012	4.06 ± 1.40	5.15 ± 1.43	0.020
Mesomorphy	4.36 ± 1.47	5.89 ± 1.71	0.002	4.33 ± 1.18	5.01 ± 1.66	0.173
Ectomorphy	1.55 ± 1.32	0.48 ± 0.42	0.000	2.33 ± 1.26	1.84 ± 1.64	0.165

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