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NEW DXA DIAGNOSTIC INDEXES OF ABDOMINAL OBESITY

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ABSTRACT

Aim: Cushing's syndrome (CS) is associated with weight gain and extreme central, visceral, abdominal obesity which is confirmed with dual-energy X-rays absorptiometric (DXA) diagnostic cut-off point (CP) values of central obesity indexes (COI), determined as an android to gynoid tissue and fat mass ratios. These best differentiate CS from non-CS obese women matched with CS according to their age and BMI. The aim of this study was to determine the CP values of new DXA indexes of central, abdominal obesity as a ratio of android and trunk to legs as well as trunk and legs to total tissue and fat mass that best differentiate CS and matched non-CS obese women in order to confirm central abdominal obesity, and to determine their normal CP values that best differentiate healthy non-obese women from CS and non-CS obese women, and to exclude abdominal obesity completely.

Material and Methods: DXA indexes of abdominal obesity, calculated as a ratio of regional body fat and tissue mass compartments android to legs (A/L), trunk to legs (Tr/L), trunk to total (Tr/To) and legs to total (L/To) values were determined among 4 groups. Each group consisted of 18 women: 1st group of CS, 2nd group of obese women (O_1) not different according to their age and BMI from CS, 3rd group of obese women (O_2) with higher BMI of 35 ± 1.2 kg and a 4th group of non-obese, healthy women (C) with a normal BMI. Diagnostic accuracy (DG) of CP values of DXA indexes of abdominal obesity and indexes of normal body fat distribution (BFD) were determined.

Results: A/L, Tr/L, Tr/To, and L/To DXA indexes were significantly different between CS and O_1 as well as between non-CS women O_2 compared to O_1 and C. These indexes had a highly significant correlation among each other and also in relation to their BMI ($p < 0.0001$). A/L-Tm CP value of 0.3 best differentiated the CS from group O_1, with the highest DG of 100 % and an A/L-Fm CP value of 0.26 differentiated them with a DG of 94.44% and sensitivity of 100 %. An A/L-Tn CP value of 0.23 and an A/L-Fn CP value of 0.25 best differentiated CS and C as well as O_2 and C for the highest DG of 100 %.

Conclusions: DXA indexes A/L, Tr/L, Tr/To and L/To values were significantly different among the four groups. These values correlated significantly among them and with their BMI in non-CS groups, thus confirming a BMI increase association with a more pronounced abdominal BFD. An A/L-Tm CP value of 0.3 and an A/L-Fm CP value of 0.26 were discovered as the best DXA diagnostic indexes of extreme abdominal obesity in CS and these could also be used in discovering abdominal BFD in non-CS obese women with metabolic syndrome (MS). An A/L-Tn CP value of 0.23 and an A/L-Fn CP value of 0.25 were discovered as the best DXA diagnostic indexes of normal BFD which completely excluded abdominal obesity.

Keywords: DXA, abdominal obesity, DXA obesity indexes, cut-off point values

INTRODUCTION

Cushing's syndrome (CS) is caused by prolonged exposure to elevated levels of either endogenous glucocorticoids or exogenous glucocorticoids. Metabolic syndrome (MS) may indicate the presence of CS. It is an exaggerated, overemphasized MS. Many CS patients have glucose metabolism abnormalities, impaired glucose tolerance or diabetes, hypertension, elevated triglyceride levels, and low HDL-C, just as abdominal obese subjects with MS. Almost two thirds of CS patients fulfil at least three criteria for MS [1, 2]. MS shares many characteristics of CS, and cortisol might play a role in the development of MS at both a central and a peripheral level [3]. Similarities between MS and CS, and the reversibility of the features of CS, suggest that cortisol may contribute to the pathophysiology of both conditions. Emerging data suggest that patients with MS show hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, which leads to a state of "functional hypercortisolism" [4]. This abnormality could be central in origin, due to the hypersecretion of CRF or ACTH; alternatively, it could represent an adaptive phenomenon, secondary to a state of functional cortisol resistance [5, 6]. Chronic stress, decreased sleep duration, and low birth weight have all been implicated in this central activation of the HPA axis, although the precise underlying mechanism remains elusive.

Hypercortisolism, caused by prolonged exposure to elevated levels of endogenous glucocorticoids, such as in CS, results in abnormal adipose tissue (AT) distribution and profound body composition changes, including increased central, abdominal, visceral adiposity and decreased lean mass that is strongly linked to cardiovascular and metabolic risks [7]. Obesity and, especially, central body fat distribution (BFD) are known risk factors for cardiovascular and metabolic diseases. The elevated incidence of diabetes and premature atherosclerosis (directly related to the length of exposure to hypercortisolism) and increased mortality (particularly cardiovascular mortality) relative to the general population show that the predictive value of MS is also valid in CS and opposite [1, 2, 8, 9, 10]. For this reason, the evaluation of body composition and BFD is clinically important in CS and in non-CS obese patients. Measurements of body composition and BFD have become a research tool to study the metabolic effects of aging, obesity, and various diseases, such as CS. Effective methods for assessing abdominal, visceral fat are important in the investigation of its role regarding the increased health risks associated with obesity [11, 12, 13].

Dual-energy x-ray absorptiometry (DXA) is considered to be a gold standard for the assessment of bone health and body composition because of its reliability, precision, and the fact that it is based on a three-compartment model. DXA is used to quantify abdominal fat mass and enables precise, accurate body composition and BFD assessment. It can also be used in the determination of abdominal obesity indexes values. In obese women, it was found that DXA could predict intra-abdominal AT and that the abdominal to peripheral regional tissue and fat mass ratios may provide a better index of the cardiometabolic impact of body fat composition than absolute quantification of each deposit independently [14, 15, 16].

Differentiation of CS patients from those that have MS in the general population with similar symptoms and signs of CS, and differentiation of simple peripheral obese patients from abdominal obese and non-obese patients also presents a considerable challenge for the physician [17, 18, 19]. The limitation of DXA derived body composition and BFD is that there are currently no universally accepted reference ranges for body composition based on DXA results. Also, to date CP values of the DXA indexes of abdominal obesity have not been provided except in one recent study by Shubeska et al. [20]. That study determined CP values of the DXA central obesity indexes (COI), calculated as a ratio of android to gynoid tissue and fat mass and their percentages that discovered extreme central, visceral, abdominal obesity in CS and best differentiated CS from non-CS obese women, matched with CS according to their age and BMI.

This study is a continuation of the previous study by Shubeska et al. [20] on the same group of examinees. The goal is to develop CP values of new DXA indexes of central, abdominal obesity as ratios of android and trunk to legs, as well as trunk and legs to total fat and tissue mass and their percentages that best differentiate CS and O_1 and confirm central abdominal obesity, and to determine their normal CP values that best differentiate group C from CS, O_1 and O_2 and exclude abdominal obesity.

MATERIAL AND METHODS

This transversal study was organized and realized at the University Clinic of Endocrinology, Diabetes and Metabolic Disorders, Faculty of Medicine, at the "Sts Cyril and Methodius" University of Skopje. DXA assessment of body composition and BFD was performed in four groups of women, each consisting of 18 subjects: the 1st group with Cushing's syndrome (CS), with clinically confirmed CS with a Body Mass Index (BMI) (30.25 ± 5.64 kg/m^2) and an age of 43.58 ± 13.58 years, the 2nd group of obese women, O_1, matched with CS according to their BMI (29.8 ± 4.08 kg/m^2) and age (40.4 ± 12.05 years), the 3rd group of obese women O_2 with age of 45 ± 8 years and a BMI value of 35 ± 1.2 kg/m^2, being higher compared to O_1 and CS; and the 4th group C of healthy women with normal BMI (21.59 ± 1.35 kg/m^2) and age (40.09 ± 2.72 years). All examined women were not different according to their age. BMI in C was significantly lower compared to CS, O_1 and O_2. BMI was significantly lower in group O_1 compared to O_2 ($p < 0.0001$). CS had not received any treatment at the time of the assessment and had typical signs and symptoms of CS including extreme central, visceral obesity. Anthropometric, DXA, hormonal and metabolic parameters confirmed the CS diagnosis. Written informed consent was obtained from all patients before commencement of the study.

Central obesity index one (COI_1) was determined as a ratio of android (A) to gynoid (G) tissue mass COI_1 = At/Gt; COI_2 as a ratio of A to G fat mass COI_2 = Af/Gf; COI_3 as a ratio of A and G tissue % fat COI_3 = At%/Gt% fat, and COI_4 as a ratio of A to G fat % COI_4 = Af%/Gf%. Their values were significantly different among the examined groups. COI_1 values were highest among those with CS, at 0.68±0.09, compared to O_1 (0.46 ± 0.53), O_2 (0.55±0.06) and C (0.38 ± 0.04) as well as the COI_2 value of 0.76 ± 0.16 compared to the correspondent values 0.42 ± 0.09, 0.55 ± 0.08 and 0.25 ± 0.07, respectively. COI_3 values were also significantly highest in the CS group, at 1.07 ± 0.15, compared to O_1 (0.88 ± 0.12), O_2 (0.99±0.07), and C (0.64 ± 0.15) as well as a COI_4 value of 1.12 ± 0.14, compared to the correspondent values of 0.91 ± 0.12, 1 ± 0.07, 0.65 ± 0.15.

Body weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale, with subjects minimally clothed, in light-weight underwear. Standing height was measured to the nearest 0.1 cm with the shoes removed and the head in the Frankfurt plane using a standard stadiometer. BMI was calculated as the patient's weight in kilograms divided by the height in meters squared.

DXA assessment in this study was performed with the DXA System Lunar DPX-NT, which uses an enCore Windows-XP Professional OS based computer, calibrated daily according to the standard procedures for maintenance and use, as recommended by the manufacturer. For body composition measurements, the entire body of each subject was scanned. During the DXA scan, subjects were positioned following the standard manufacturer's protocols in the supine position, while the x-ray scanner performed a series of transverse scans, measured at 1 cm intervals from the top of the head to the bottom of the toes.

Android (A) and legs (L) regions as well as Trunk (Tr) and Total (To) regions were automatically determined, as defined by the manufacturer's instructions as well as A, L, Tr and To tissue (T) and fat mass (F) and their percentages (Tf% and F%). Four DXA indexes of central, abdominal obesity were determined: A/L ratios (A/L-T, A/L-F, A/L-Tf%, A/L-F%), Tr/L ratios (Tr/L-T, Tr/L-F, Tr/L-Tf%, Tr/L-F%), Tr/To (Tr/To-T, Tr/To-F, Tr-Tf%, Tr-F%) and L/To ratios (L/To-T, L/To-F, L/To-Tf%, L-ToF%).

The cut-off point (CP) values of the DXA indexes of central, abdominal obesity (CP-m) were determined to best differentiate CS with confirmed abdominal obesity from O_1, healthy control obese women matched for age, menopausal status, and BMI: A/L-m values (A/L-Tm, A/L-Fm, A/L-Tf%m and A/L-F%m), Tr/L-m ratio values (Tr/L-Tm, Tr/L-Fm, Tr/L-Tf%m and Tr/L-F%m), Tr/To-m values (Tr/To-Tm, Tr/To-Fm, Tr/To-Tf%m and Tr/To-F%m) and L/To-m values (L/To-Tm, L/To-Fm, L/To-Tf%m and L/To-F%m).

Cut-off point values of DXA indexes of normal body composition and fat distribution (CP-n) that best differentiated CS and C as well as O_1 and O_2 from C and excluded abdominal obesity were determined: A/L-n values (A/L-Tn, A/L-Fn, A/L-Tf%n and A/L-F%n), Tr/L-n values (Tr/L-Tn, Tr/L-Fn, Tr/L-Tf%n and Tr/L-F%n), Tr/To-n ratio values (Tr/To-Tn, Tr/To-Fn, Tr/To-Tf%n and Tr/To-F%n) and L/To-n values (L/To-Tn, L/To-Fn, L/To-Tf%n and L/To-F%n).

Cut-off point values were determined for all four DXA indexes and their sensitivity (S), specificity (SP), positive and negative predictive value (PPV and NPV) and diagnostic accuracy (DG) were evaluated in the following way:

• Sensitivity (true positive rate) is the probability that a test result – extreme visceral obesity – will be positive when CS is present.

• Specificity (true negative rate) is the probability that a test result will be negative; there is no extreme central BFD when CS is not present in C and O.

• Positive predictive value (PPV): the proportion of those with a positive test result (extreme central BFD) of those who actually have CS.

• Negative predictive value (NPV): the proportion of those with a negative test result (without extreme central obesity) who do not have CS (C and O).

• Diagnostic accuracy (effectiveness) was expressed as a proportion of correctly classified subjects (true positive rate + true negative rate) among all subjects.

Statistical analyses were performed using the statistical software program SPSS for Windows, version 19.0. Variables were presented as means ± standard deviations (SD). P values of < 0.05 were considered to be statistically significant. For normally distributed variables, parametric tests were used for analysis. Differences among the groups were evaluated by performing an analysis of variance (ANOVA) for normally distributed parameters. Correlation coefficients were determined by Pearson's product moment.

RESULTS

The values of the DXA indexes ratios of Android/Legs, Trunk/Legs and Trunk/Total determined during body composition assessment, in total body scans, were significantly different among the 4 examined groups and they were significantly highest in the CS group and lowest in group C, compared to all other groups ($p < 0.0001$). Legs/Total ratios indexes values were significantly the lowest in the CS group, yet higher in group O_2, and even higher in O_1, and were significantly the highest in group C.

A/L-T, Tr/L-T and Tr/To-T as well as A/L-F, Tr/L-F and Tr/To-F values were significantly higher in O_2 compared to O_1 and C, and in CS compared to O_1 and C ($p<0.0001$). A/L-Tf%, Tr/L-Tf% and Tr/To-Tf% values were significantly higher in O_2 compared to O_1, ($p<0.036$), ($p<0.023$) and NS respectively. A/L-F%, Tr/L-F% and Tr/To-F% values were significantly higher in

Table 1. *Significance of the difference between A/L, Tr/L, Tr/To and L/To ratios values of tissue and fat mass and their percentages in CS, O and C*

Variable	CS	O_1	O_2	C	mean	P - value
A/L T g	0.35±0.06	0.23±0.04	0.30±0.03	0.18±0.02	0.26±0.07	0.0001
A/Legs F g	0.43±0.09	0.23±0.07	0.33±0.06	0.14±0.04	0.28±0.13	0.0001
A/L Tfat%	1.23±0.19	0.99±0.16	1.12±0.15	0.76±0.18	1.03±0.24	0.0001
A/Legs F%	1.27±0.20	1.03±0.17	1.15±0.16	0.78±0.18	1.06±0.25	0.0001
Trunk/Legs T g	2.01±0.34	1.43±0.20	1.71±0.15	1.28±0.13	1.61±0.36	0.0001
Trunk/Legs F g	2.31±0.53	1.37±0.37	1.84±0.35	1.07±0.22	1.65±0.60	0.0001
Trunk/Legs Tfat%	1.14±0.16	0.95±0.13	1.05±0.13	0.83±0.11	0.99±0.18	0.0001
Trunk/Legs Fat%	1.17±0.17	0.96±0.13	1.07±0.13	0.84±0.11	1.01±0.18	0.0001
Tr/To Tg	0.56±0.05	0.49±0.03	0.53±0.02	0.47±0.02	0.52±0.05	0.0001
Tr/To F g	0.60±0.06	0.50±0.05	0.56±0.04	0.45±0.04	0.53±0.07	0.0001
Tr/To Tfat%	1.07±0.06	1.02±0.06	1.05±0.04	0.97±0.06	1.03±0.07	0.0001
Tr/To F%	1.09±0.062	1.03±0.06	1.06±0.043	0.98±0.06	1.04±0.07	0.0001
L/To T g	0.28±0.03	0.35±0.03	0.31±0.02	0.37±0.02	0.33±0.04	0.0001
L/To F g	0.27±0.05	0.38±0.05	0.31±0.03	0.43±0.05	0.35±0.08	0.0001
L/To Tfat%	0.95±0.08	1.08±0.09	1.00±0.07	1.18±0.08	1.05±0.12	0.0001
L/To F%	0.94±0.08	1.08±.09	0.94±0.10	1.21±0.16	1.04±0.16	0.0001

CS – Cushing's Syndrome; O – obese; C – non-obese

O_2 compared to O_1 ($p < 0.037$), ($p < 0.019$) and NS respectively. A/L-Tf%, A/L-F%, Tr/L-Tf%, and Tr/L-F% values were significantly higher in CS compared to O_1 ($p < 0.0001$). Tr/To-Tf% and Tr/To-F% were significantly higher in CS compared to O_1 ($p < 0.006$) and ($p < 0.004$), respectively.

L/To-T and L/To-F were significantly lower in O_2 compared O_1 ($P < 0.0001$). L/To-Tf% and L/To-F% were significantly lower in O_2 compared to O_1 ($p < 0.005$) and ($p < 0.0001$), and they were significantly lower in CS compared to O_1 ($p < 0.0001$). L/To-T and L/To-F ratio indexes values were significantly the lowest in the CS group, higher in group O_2, and even higher in O_1, and significantly highest in C.

A/L-T, Tr/L-T, Tr/To-T and L/To-T as well as A/L-F, Tr/L-F, Tr/To-F and L/To-F DXA indexes of central obesity correlated significantly among the groups as well as with their percentage values. Also, BMI correlated significantly with all of the examined DXA indexes in a group of non-CS women (C, O_1 and O_2) ($p<0.0001$).

Cut off point values of A/L-m, Tr/L-m, Tr/To-m and L/To-m DXA indexes of central, abdominal obesity that best differentiated extreme central, abdominal, visceral body fat distribution in CS women from group O_1 were determined.

The A/L-Tm cut off point value of 0.3 best of all DXA indexes differentiated CS from O_1 for S, SP, PPV, NPV and DG of 100%. A/L-Fm CP value of 0.26 differentiated CS from O_1 for S and NPV of 100%, SP of 88.89 %, PPV of 90 % and DG of 94.44 %. An A/L-Tf%m CP value of 1.1 and A/L-F%m of 1.05 differentiated CS from O_1 with DG of 77.78 %. The Tr/L-Tm cut off point value of 1.6 and Tr/L-Fm CP value of 1.8 differentiated CS and O_1 for DG of 88.89 %. Tr/L-Tf%m of 1.0 and Tr/L-F%m of 1.1 differentiated CS from O_1 with DG of 72.22 % and 77.78 %, respectively. The results are shown in table 2.

Tr/To-Tm cut off point value of 0.52 and Tr/To-Fm CP value of 0.53 differentiated the CS group from the O_1 group for a DG of 88.89 % and 83.33 %, respectively. A Tr/To-Tf%m CP value of 1.07 and Tr/To-F%m CP value of 1.1 differentiated the CS group from the O_1 group, with a DG of 69.44 % and 72.22 %, respectively. L/To-Tm CP value of 0.29 and L/To-Fm CP value of 0.31 differentiated the CS group from the O_1 group with a DG of 86.11 %. L/To-Tf%m of 1.0 and L/To-F%m of 1.0 differentiated the CS group from the O_1 group with DG of 80.56 % and 86.11 %, respectively. The results are shown in table 3.

Cut off point values of DXA indexes of normal body composition and fat distribution, A/L-n, Tr/L-n, Tr/To-n and L/To-n that best differentiated CS women from group C were then determined.

Table 2. *S, SP, PPV, NPV and DG of A/L and Tr/L ratios of tissue and fat mass and their percentages cut-off point values in differentiation of CS and O_1*

Cushing's to suspected to Cushing (O_1) DXA ratios								
	Android to legs DXA ratios				Trunk to legs DXA ratios			
Variables	A/L-Tm 0.3	A/L-Fm 0.26	A/L-Tf%m 1.1	A/L-F%m 1.05	Tr/L-Tm 1.6	Tr/L-Fm 1.8	Tr/L-Tf%m 1.0	Tr/L-F%m 1.1
Sensitivity (%)	100	100	66.67	94.44	94.44	83.33	77.78	61.11
Specificity (%)	100	88.89	94.12	61.11	83.33	94.44	66.67	94.44
PPV (%)	100	90	92.31	70.83	85	93.75	70	91.67
NPV (%)	100	100	94.12	91.67	93.75	85	75	70.83
DG (%)	100	94.44	77.78	77.78	88.89	88.89	72.22	77.78

Table 3. *S, SP, PPV, NPV and DG of Tr/To and L/To ratios of tissue and fat mass and their percentages cut-off point values in differentiation of CS and O_1*

Cushing's to suspected to Cushing (O1) DXA ratios								
	Trunk to total DXA ratios				Legs to total DXA ratios			
Variables	Tr/To-Tm 0.52	Tr/To-Fm 0.53	Tr/To-Tf%m 1.07	Tr/To-F%m 1.1	L/To-Tm 0.29	L/To-Fm 0.31	L/To-Tf%m 1.0	L/To-F%m 1.0
Sensitivity (%)	88.89	88.89	50	50	77.78	83.33	66.67	77.78
Specificity (%)	88.89	77.78	88.89	94.44	94.44	88.89	94.44	94.44
PPV (%)	88.89	80	81.82	90	93.33	88.24	92.31	93.33
NPV (%)	88.89	87.5	64	65.38	80.95	84.21	73.91	94.44
DG (%)	88.89	83.33	69.44	72.22	86.11	86.11	80.56	86.11

Table 4. *S, SP, PPV, NPV and DG of A/L and Tr/L ratios of tissue and fat mass and their percentages cut-off point values in differentiation of CS and C*

Cushing's to young control healthy women (C)								
	Android to legs DXA ratios				Trunk to legs DXA ratios			
Variable	A/L-Tn 0.23	A/L-Fn 0.25	A/L-T%fn 0.95	A/L-F%n 1.0	Tr/L-Tn 1.45	Tr/L-Fn 1.50	Tr/L-T%fn 0.95	Tr/L-F%n 1.0
Sensitivity (%)	100	100	100	100	94.44	100	88.89	83.33
Specificity (%)	100	100	88.89	88.89	100	94.44	88.89	100
PPV (%)	100	100	90	90	100	94.74	88.89	100
NPV (%)	100	100	100	100	94.74	100	88.89	85.71
DG (%)	100	100	94.44	94.44	97.22	97.22	88.89	91.67

A/L-Tn and A/L-Fn cut off point values of 0.23 and 0.25 best differentiated CS and C for S, SP, PPV, NPV and DG for 100 %. A/L-Tf%n value of 0.95 and A/L-F%n of 1.0 differentiated CS and C for DG of 94.44 % and with S and NPV value of 100 %. Tr/L-Tn and Tr/L-Fn cut off point values of 1.45 and 1.50, respectively, best differentiated CS and C for a DG of 97.22 %. Tr/L-Tf%n value of 0.95 differentiated CS and C for a DG of 88.89 %, and Tr/L-F%n value of 1.0 for a DG of 91.67 %. The results are shown in table 4.

Table 5. *S, SP, PPV, NPV and DG of Tr/To and L/To ratios of tissue and fat mass and their percentages cut-off point values in differentiation of CS and C*

Cushing's to control healthy women (C) DXA ratios								
	Trunk to total DXA ratios				Legs to total DXA ratios			
Variables	Tr/To-Tn 0.5	Tr/To-Fn 0.53	Tr/To-Tf%n 1.01	Tr/To- F%n 1.05	L/To-Tn 0.34	L/To-Fn 0.37	L/To- Tf%n 1.1	L/To-F%n 1.07
Sensitivity (%)	100	100	88.89	66.67	100	100	100	94.44
Specificity (%)	94.44	88.89	72.22	88.89	88.89	94.44	88.89	88.89
PPV (%)	94.74	90	69.57	85.71	90	94.74	90	89.47
NPV (%)	100	88.89	86.67	72.73	100	100	100	94.12
DG (%)	97.22	94.44	80.56	77.78	94.44	97.22	94.44	91.67

Tr/To-Tn and Tr/To-Fn cut off point values of 0.5 and 0.53 best differentiated CS and C for a DG of 97.22 % and 94.44 %, respectively. Tr/To-Tf%n CP value of 1.01 and Tr/To-F%n of 1.05 differentiated CS and C for DG of 80.56 % and 77.78 %, respectively. L/To-Tn and L/To-Fn cut off point values of 0.34 and 0.37 best differentiated CS and C for DG of 94.44 % and 97.22 %, respectively. L/To-Tf%n CP value of 1.1 and L/To-F%n of 1.07 differentiated CS and C for DG of 94.44% and 91.67 %, respectively. The results are shown in table 5.

Table 6. *S, SP, PPV, NPV and DG of A/L and Tr/L ratios cut-off point values in differentiation of O_1 and O_2 with C*

Obese women (O_1 and O_2) to control healthy women (C) DXA ratios																
	Android to legs DXA ratios								Trunk to legs DXA ratios							
Variables	A/L-Tn 0.23		A/L-Fn 0.25		A/L-T%fn 0.95		A/L-F%n 1.0		Tr/L-Tn 1.45		Tr/L-Fn 1.5		Tr/L-Tf%n 0.95		Tr/L-F%n 1.0	
	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C
Sensitivity (%)	83.33	100	61.11	100	88.89	100	88.89	100	33.33	100	50	100	50	83.33	44.44	77.78
Specificity (%)	88.89	100	94.44	100	88.89	88.89	72.22	88.89	88.89	88.89	94.44	94.44	66.67	88.89	94.44	94.44
PPV (%)	88.24	100	91.67	100	88.89	90	76.19	90	75	90	90	94.74	60	88.24	88.89	93.33
NPV (%)	88.89	100	70.83	100	88.89	100	86.67	100	57.14	100	65.38	94.44	66.67	84.21	62.96	80.95
DG (%)	86.11	100	77.78	100	88.89	94.44	80.56	94.44	61.11	94.44	72.22	97.22	58.33	86.11	69.44	86.11

Cut off point values A/L-Tn of 0.23 and A/L-Fn of 0.25 best differentiated C and O_2 for S, SP, PPV, NPV and DG for 100%, but differentiated C from O_1 with lower DG of 86.11% and 77.78%, respectively. Also, CP value of A/L-Tf%n of 0.95 and an A/L-F%n value of 1.0 differentiated C from O_2 for DG of 94.44%, but differentiated C from O_1 with a lower DG of 88.89% and 80.56%, respectively. Cut off point values Tr/L-Tn of 1.45 and Tr/L-Fn of 1.5 best differentiated C and O_2 for DG of 94.44% and 97.22%, respectively, but differentiated C from O_1 with lower DG of 61.1% and 72.22%, respectively. Also, CP value Tr/L-Tf%n of 0.95 and Tr/L-F%n value of 1.0 differentiated C from O_2 for DG of 86.11%, but differentiated C from O_1 with lower DG of 58.33% and 69.44%, respectively. The results are shown in table 6.

Table 7. *S, SP, PPV, NPV and DG of Tr/To and L/To ratios cut-off point values in differentiation of O_1 and O_2 with C*

Obese women (O1 and O2) to control healthy women (C) DXA ratios																
Variable	Trunk to total DXA ratios								Legs to total DXA ratios							
	Tr/To-Tn 0.50		Tr/To-Fn 0.53		Tr/To-Tf%n 1.03		Tr/To-F%n 1.05		L/To-Tn 0.34		L/To-Fn 0.37		L/To-Tf%n 1.1		L/To- F%n 1.07	
	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C	O_1-C	O_2-C
Sensitivity (%)	55.56	100	50	100	50	72.22	44.44	66.67	72.22	94.44	55.56	100	61.11	94.44	83.33	94.44
Specificity (%)	83.33	94.44	88.89	88.89	88.89	88.89	88.89	88.89	72.22	88.89	83.33	94.44	88.89	88.89	61.11	88.89
PPV (%)	76.92	94.74	81.82	90	81.82	86.67	80	85.71	72.22	89.47	76.92	94.74	84.62	89.47	68.18	89.47
NPV (%)	83.33	100	64	100	88.89	76.19	88.89	72.73	72.22	88.89	65.22	94.44	69.57	94.12	78.57	94.12
DG (%)	69.44	97.22	69.44	94.44	69.44	80.56	66.67	77.78	72.22	91.67	69.44	97.22	75	91.67	72.22	91.67

The cut-off point values for Tr/To-Tn were at 0.50 and for Tr/To-Fn at 0.53 best differentiated C and O_2 for DG of 97.22% and 94.44%, respectively, but differentiated C from O_1 with a lower DG of 69.44%. Also, a CP value for Tr/To-Tf%n at 1.03 and a Tr/To-F%n value of 1.05 differentiated C from O_2 for DG of 80.56% and 77.78%, but also differentiated C from O_1 with a lower DG of 69.44% and 66.67%, respectively. The cut off point values for L/To-Tn at 0.34 and for L/To-Fn at 0.37 best differentiated C and O_2 for DG at 91.67% and 97.22%, respectively, but also differentiated C from O_1 with a lower DG of 72.22% and 69.44%. Also, a CP value for L/To-Tf%n at 1.1 and for L/To-F%n value at 1.07 differentiated C from O_2 for DG at 91.67%, but differentiated C from O_1 with a lower DG of 75% and 72.22%, respectively. The results are shown in table 7.

DISCUSSION

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have adverse effects on health, leading to reduced life expectancy and/or increased health problems [21, 22]. Very recently, the World Obesity Federation argued that obesity was considered as a chronic, relapsing, progressive, disease process that requires intervention. Obesity is a complex and multifactorial chronic disease, originating from either a genetic, environmental, or behavioural interchange, caused by an imbalance between energy intake and expenditure [23, 24, 25, 26].

Metabolic syndrome is defined as a complex of interrelated risk factors, including obesity (particularly central obesity), impaired fasting glucose, hypertension, elevated serum triglycerides, and low high density-lipoprotein cholesterol. Insulin resistance is considered to be the factor linking these different metabolic abnormalities. Obese individuals with MS have an especially higher risk for stroke, coronary artery disease, hypertension, cardiovascular disease related mortality and type 2 diabetes, fatty liver and several cancers, along with a number of other chronic diseases, when compared with individuals of normal body weight and BFD [1, 27, 28].

It is well established that the location of excess body fat is more important than the total quantity of adipose tissue when predicting the cardiometabolic consequences of obesity. It is now generally believed that intra-abdominal fat is the depot that conveys the biggest health risk [29, 30]. Android obesity in CS and in non-CS abdominal obese individuals with MS, which is predominantly visceral, intra-abdominal, is more predictive of adipose-related comorbidities than gynecoid obesity, which has a relatively peripheral (gluteal) distribution [31, 32, 33].

Individuals with CS undergo profound body composition changes, including increased central, visceral adiposity and decreased lean mass that is especially strongly linked to cardiovascular and metabolic risks. CS is associated with weight gain and extreme central, visceral, abdominal obesity. CS patients have higher visceral fat, visceral to total AT ratios and visceral to subcutaneous AT ratios on CT scan [34, 35, 36]. Effective treatment of hypercortisolism improves each of the five MS components. Remission from CS dramatically improves body composition abnormalities, decreases weight and nearly all AT depots, including visceral adipose tissue, alters fat distribution, resulting in decreased visceral/total fat, visceral fat/skeletal muscle ratios and visceral/subcutaneous fat ratio. From the alterations in body composition observed after normalization of a hypercortisolic state, it was concluded that cortisol in CS, directly or indirectly, increased the total mass of AT and redistributed AT from peripheral to visceral depots the same as body AT distribution in non-CS obese individuals before weight loss [37].

As visceral obesity is associated with poor prognosis, metabolic disturbances and a degree of pathology in several chronic diseases, it is of great importance to identify methods that quantify adipose tissue accurately and can specifically depict abdominal, visceral adipose tissue from total adipose tissue [11]. At present, reliable imaging techniques for measuring visceral, abdominal adiposity include magnetic resonance imaging (MRI) and computed tomography (CT), which directly measure intra-abdominal adipose tissue, allowing for quantification of several fat depots. CT may provide a better way to discern between fat and other tissues, but MRI has the advantage that it does not expose subjects to ionising radiation. However, both methods are costly, time-consuming, inconvenient to apply, and often unavailable for clinical and research purposes [38, 39].

DXA can accurately measure body composition with high-precision, low X-ray exposure, and a short-scanning time [40, 41]. DXA is a very reliable method, and its results are repeatable. In addition, the method is safe and presents little burden to the subject. DXA is fast becoming the new gold standard because it provides body composition assessment with a higher degree of precision with only one measurement, and it has the ability to show exactly where fat is distributed throughout the body. DXA measures three of the principal components of the body: fat mass, lean soft-tissue mass (comprising muscle, inner organs, and the body water), and the bone mineral content. Lunar DXA systems directly measure and calculate total fat, lean and bone tissue, instead of estimating body composition [40]. The DXA method is the gold standard for assessment of bone health and body composition that provides accurate, comprehensive, precise measurements of total body fat percentage, along with segmental BFD in regions such as the arms, legs, android (waist) and gynoid (hips). For routine clinical use, estimation of regional AT distribution must be easy and cost effective [42, 43]. Agreement between DXA and whole-body CT fat mass has been found to be very high, with correlations of 0.99. DXA is a good alternative to CT for predicting total abdominal fat among the elderly population [44, 45]. DXA is used to quantify abdominal fat mass. This method allows us to determine, more accurately, the degree of obesity of a particular patient as well as body fat distribution.

The first study concerning the measurements of body composition in CS using DXA and CT was published by Wajchenberg et al. [46]. In that study, patients with CS had no increase in total body fat, but had a higher intra-abdominal fat area compared to obese subjects with the same anthropometric parameters. It was demonstrated that increased visceral BFD in both female and male patients with CS may increase the risk of the MS in that group of patients [11, 34, 41]. A reduction of the total adipose tissue volume and a redistribution of adipose tissue from visceral to peripheral depots were found by using a multiscan CT technique after normalization of the hypercortisolic state in women with CS [37]. In Jebb's study [47], patients with Cushing's syndrome had higher visceral versus total adipose tissue ratios, suggesting that glucocorticoids play a pivotal role in the pathogenesis of central obesity. The impact of CS on whole and regional body composition and energy metabolism was assessed by DXA in Burt's study [48], which showed that mean percentage fat mass was significantly greater by 30% in CS. Lean body mass was significantly lower by 15% in CS, and the proportion of lean tissue in the limbs was 12% less than normal. Burt concluded that fat mass was higher and lean body mass was lower among those with CS [35, 48]. Patients with CS had less than a twofold increase in subcutaneous fat and greater than a fivefold increase in intra-abdominal fat, compared with values in healthy subjects. These findings suggested that fat in different body compartments responded dif-

ferently to disease processes and that CT can be used to measure these changes [49]. The study by Schafroth [50] showed that, among a subgroup of 12 CS patients, trunk fat mass was significantly elevated, compared to obese controls (19.2 kg vs. 14.7 kg, $p < 0.01$), whereas total fat mass was not significantly increased. Body composition and fat distribution measured by DXA were evaluated in women with CS, and these were compared with healthy control women matched for age, menopausal status, and BMI. The study then discovered that trunk fat mass percentage was significantly higher in CS compared to controls and leg fat mass was not significantly different between the two groups [51, 52, 53].

DXA is a diagnostic test to detect abnormal body composition. The DXA method determines absolute (kg) and relative (%) total bone, lean, and fat body mass and separately their regional (segmental) values on arms, legs, head and trunk (including the ribs, pelvis, abdominal, thoracic and lumbar spine). Determining body composition as a single diagnostic measure of each regional component is very problematic, since normal values will require the development of normative databases for the different components of body composition (bone, fat, and lean mass) for different populations of patients at different ages. In addition to the uncertainties of establishing normal values for other components of body composition, it also is unclear how a single measure of body composition would be used for the medical management of a patient. A single DXA measure, especially of fat mass or fat mass percentage in different body regions would not be used in the medical management of the patients, particularly in MS and with all consecutive complications. DXA as a gold standard can help improve these issues by establishing equations for a more accurate clinical assessment of lean, tissue, and fat body mass. It is also important to establish diagnostic cut off points for normal and abnormal values of the established DXA equations.

Body fat distribution is determined by DXA via the relationship of the regional fat compartments. Some relationship ratios between central, android, abdominal (predominantly visceral) regional tissue and FM to peripheral gynoid regional parts of the body in patients with Cushing's syndrome could be used as diagnostic criteria and indicators of visceral, abdominal obesity in patients with CS and in non-CS obese patients. Shubeska et al. [20] evaluated the differences of the body composition and BFD, as measured by DXA, in women with CS with confirmed extreme abdominal, visceral obesity in comparison to healthy obese control women matched for age, menopausal status, and BMI. The central obesity index (COI) was determined as a ratio between android to gynoid tissue and fat mass, and its cut off point values confirmed extreme abdominal, visceral BFD in CS and differentiated significantly and precisely CS from non-CS obese with the same BMI as those with CS. It was discovered that the COI could be used as a diagnostic test procedure and diagnostic criterion of extreme central, abdominal obesity in CS as well as in different types of obesity (non-CS) [20].

There is no consensus in the literature regarding diagnostic cut off points for visceral obesity that would indicate increased cardiovascular risk, and there are no diagnostic cut off points for abdominal, visceral obesity for DXA relations of central to peripheral body fat compartments. It is also essential to develop quantitative criteria for defining abdominal obesity relative to the metabolic disturbances, and it is important to establish diagnostic CP for normal and abnormal values. Relationships between central abdominal regional tissue and fat mass to peripheral regional parts of the body in CS are needed as diagnostic DXA indexes of central abdominal obesity and reference values of some DXA indexes for normal and pathologic body composition have to be determined that will be useful for all populations of patients at different ages [20].

The objective of this study was to develop predictive equations for estimating abdominal adiposity, measured by DXA, and to establish CP values to define abdominal adiposity as well as normal BFD. Four DXA indexes were determined A/L, Tr/L, Tr/To and L/To in order to best differentiate CS and O_1 and to confirm visceral, abdominal obesity in CS and also to best differentiate CS and C as well as O_1 and O_2 from C, in order to discover normal body fat distribution in C and completely exclude abdominal obesity. Their values were significantly different among the 4 groups.

A/L-T, Tr/L-T and Tr/To-T as well as A/L-F, Tr/L-F and Tr/To-F values were significantly higher in the O_2 group compared to O_1 and C, and in CS compared to O_1 ($p < 0.0001$). Significantly higher values of A/L-T and Tr/L-T, as well as A/L-F and Tr/L-F, in CS and O_2 compared to O_1, as well as compared to C, indicated pre-

domination of central to peripheral regional tissue and fat mass, but their percentage values showed lower significance of the difference between O_2 compared to O_1. Significantly higher values for Tr/To-T and Tr/To-F in CS and O_2 compared to O_1 as well as compared to C indicated predomination of central to total tissue and fat mass. Their percentage values showed no significant difference between O_2 and O_1 and less significance in the difference between CS and C. These are, therefore, not useful DXA indexes. The Tr/To-F index value was also automatically determined by the DXA machine, but without determined reference values as a single ratio measure, thereby deeming it not useful because of the lack of CP values for that index of the DXA machine. L/To-T and L/To-F ratio indexes values were significantly lowest among those with CS, higher in group O_2, even higher in O_1, and significantly highest in group C, because of the significantly lower leg tissue and fat mass in CS and O_2 compared to O_1 and C.

A/L-T, Tr/L-T, Tr/To-T, and L/To-T as well as A/L-F, Tr/L-F, Tr/To-F, and L/To-F DXA indexes correlated significantly high among each other as well as with their percentage values, showing that tissue mass increase was associated with fat mass increase, as well as with their percentages from the total body mass. Also, BMI correlated significantly higher among all examined DXA indexes in a group of non-CS women (C, O_1 and O_2) and confirmed that BMI increase was associated with increase of indexes of abdominal, visceral obesity indicating increased abdominal BFD. Significantly higher values of these DXA indexes in group O_2,with significantly higher BMI compared to group O_1 and C, as well as in CS compared to O_1 and C, confirmed a positive association between BMI increase and central, abdominal, visceral BFD. BMI correlation with these indexes also confirmed a BMI increase positive association with abdominal BFD increase. Shubeska [16] discovered with DXA that a BMI increase in healthy women was associated with a more pronounced abdominal BFD, associated with higher degree of obesity, indicating a substantially higher risk for the development of metabolic and cardiovascular complications especially in postmenopausal women [16, 36].

CP values of the DXA indexes of central, abdominal obesity, A/L-Tm, Tr/L-Tm and Tr/To-Tm, and A/L-Fm, Tr/L-Fm and Tr/To-Fm, as well as their percentage ratios that best differentiated extreme central, abdominal, visceral body fat distribution in CS women from group O_1 were determined. A/L-Tm CP and A/L-Fm CP index ratio values were significantly higher in the CS group compared to O_1. An A/L-Tm CP value of 0.3, best of all examined DXA indexes, differentiated CS and O_1 for a DG of 100%. An A/L-Fm CP value of 0.26 differentiated CS from O_1 significantly but with lower DG of 94.44%, compared to A/L-Tm, but also with S and NPV for 100%. This is quite important for complete differentiation of CS from O_1 (not a single case of CS was missed at that value). In medical diagnosis, a perfect predictor, described as 100% sensitive, indicates that all individuals with CS are correctly identified as sick, having extreme visceral obesity. It is most important not to avoid individuals with extreme visceral obesity in order to take care of them on time, irrespective of the fact of whether they are CS patients or metabolic syndrome patients with extreme visceral obesity. These indexes differentiated with the highest DG extreme central, abdominal, visceral body fat distribution in CS women in comparison to group O_1, and they could also be used in discovering central, abdominal body fat distribution in non-CS obese women with MS, who are associated with an increased risk of MS complications. Higher abdominal, visceral tissue and fat mass deposits, and their lower amounts in peripheral regions, such as legs, confirmed the importance of determination of their regional value ratios with the DXA method. These data showed that the A/L DXA index, with its highest DG, is a worthwhile diagnostic parameter in differentiating central abdominal obesity. Percentage ratios of A/L-Tm and A/L-Fm DXA indexes, as well as Tr/L-Tm, Tr/L-Fm, Tr/To-Tm, Tr/To-Fm, L/To-Tm, L/To-Fm indexes and their percentage ratios, differentiated the two examined groups of CS and O_1, with a lower DG. Therefore they are not useful in diagnosing abdominal obesity.

The CP values of the DXA indexes of normal body composition and the BFD A/L-n, Tr/L-n, Tr/To-n and L/To-n that best differentiated with highest DG CS women from group C with normal BMI and normal BFD were also determined. An A/L-Tn CP value of 0.23 and an A/L-Fn CP value of 0.25 best differentiated C and CS, as well as C and O_2 with the highest DG of 100%. Yet, their percentage ratios differentiated them for a DG of 94.44% and with S and NPV value of 100%. CP values of these indexes and their percentage values differentiated C from O_1 with a lower DG. Tr/L-Tn, Tr/L-Fn, Tr/To-Tn, Tr/To-Fn, L/To-Tn and L/To-Fn DXA indexes CP values differenti-

ated CS and C with high DG as well as O_2 and C and have DG importance.

CONCLUSIONS

This study discovered DXA diagnostic criteria for abdominal obesity and normal body composition and BFD. DXA indexes ratio values of central android to legs as peripheral parts of the body A/L-Tm and A/L-Fm were significantly higher in the CS group compared to O_1 as a consequence of the hypercortisolism in CS. A/L-Tm CP value of 0.3 was discovered to be the best DXA index of abdominal obesity that best differentiated the CS group from group O_1 with the highest diagnostic accuracy of 100 %. The A/L-Fm index ratio value of 0.26 was discovered as a perfect index of abdominal obesity, with diagnostic accuracy of 94.44 % and a sensitivity of 100 %, thereby enabling complete differentiation of the extreme visceral, abdominal obesity in the CS group from group O_1. These indexes display, with the highest diagnostic accuracy, extreme central, abdominal, visceral body fat distribution in CS women, and they could also be used in discovering central, abdominal BFD in non-CS obese women with MS, women who are associated with an increased risk of MS complications. These data show that the A/L DXA index, with its highest diagnostic accuracy, is a worthwhile diagnostic index, parameter, and diagnostic criterion in differentiating central abdominal obesity.

Tr/L-m, Tr/To-m, and L/To-m tissue and fat mass ratios values, especially their percentage values, including A/L tissue and fat mass percentage values differentiated the CS group from group O_1 with a lower diagnostic accuracy compared to A/L-m tissue and fat mass ratios, and these are therefore not useful as diagnostic DXA indexes in the evaluation of the body composition and BFD.

An A/L-Tn CP value of 0.23 and an A/L-Fn CP value of 0.25 were discovered as the best DXA diagnostic indexes of normal BFD that best differentiated CS and C as well as O_2 and C for the highest diagnostic accuracy of 100%, but their percentage ratios values differentiated them for a lower diagnostic accuracy of 94.44% and with S and NPV value of 100%.

The DXA indexes for Tr/L-Tn, Tr/To-Tn and L/To-Tn as well as Tr/L-Fn, Tr/To-Fn and L/To-Fn tissue and fat mass ratios differentiated C and CS as well as C and O_2, with a high DG but with lower diagnostic accuracy compared to A/L-Tn and A/L-Fn. These could be used as useful diagnostic DXA indexes of normal BFD. CP values of these indexes and their percentage values differentiated O_1 from C with lower diagnostic accuracy.

Significantly higher BMI values in O_2 compared to O_1 as well as in CS compared to C were associated with significantly higher DXA indexes values and therefore confirmed the association of the higher degree of obesity with more central, abdominal BFD in obese women that was also confirmed with significantly high correlation of BMI with these DXA indexes in the non-CS groups (C, O_1, and O_2). BMI correlation with these indexes confirmed a positive BMI increase association with an abdominal BFD increase. Significantly positive correlation among tissue and fat mass indexes ratios of central obesity and their percentage values showed that tissue mass increase was associated with fat mass increase as well as their percentages from the total body mass.

Determination of the DXA indexes for CP values of abdominal obesity is very important to diagnose obese women with abdominal obesity. Abdominal obesity is the main characteristic of MS that is associated with higher cardiometabolic risks and an increased risk of other MS complications. It can be concluded that the DXA indexes of central, abdominal obesity, especially the best of them, were confirmed as useful diagnostic parameters in discovering abdominal BFD, and these could then be used as useful diagnostic criteria of MS. Also, the best DXA diagnostic indexes of normal body composition and BFD were determined. The CP values of these indexes have to be precisely confirmed on a larger group of patients because of the individual constitutional differences of the obese and non-obese women in the control group.

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Резиме

DXA-ДИЈАГНОСТИЧКИ ИНДЕКСИ НА АБДОМИНАЛНАТА ДЕБЕЛИНА

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Цел: Кушинговиот синдром е асоциран со зголемување на телесната маса и со ектремна централна, висцерална, абдоминална дебелина, која беше докажана со DXA-дијагностички пресечни точки (CP) на индексите на централна дебелина COI, одредени како количници на андоридната и гиноидната ткивна и масна маса, кои најдобро ги диференцираа CS од не CS дебелите жени, кои меѓусебно не се разликуваа според возраста и BMI. Целта на оваа студија беше да се одредат CP-вредностите на DXA-индексите на централната, абдоминална дебелина, како количници на андроидната и труп спрема нозе, како и труп и нозе спрема вкупната ткивна и масна маса, кои најдобро ги диференцираат CS од не CS дебелите жени за да се докаже централната, абдоминална дебелина, и да се одредат нормалните CP-вредности, кои најдобро ги диференцираат здравите недебели жени од CS и не CS дебелите и комплетно ја исклучуваат абдоминалната дебелина.

Материјал и методи: DXA-индексите на абдоминална дебелина пресметани како однос на регионални компартмани на телесната масна и ткивна маса андроидна/нозе (A/L), труп/нозе (Tr/L), труп/вкупна (Tr/To) и нозе/вкупна (L/To) беа одредени во 4 групи, секоја составена од 18 жени: прва група CS; втора група дебели жени (O_1), кои не се разликуваа според својата возраст и BMI со CS; трета група дебели жени (O_2) со повисок BMI 35 ± 1,2 kg во споредба со O_1 и CS и четврта група на недебели здрави жени (C) со нормален BMI. Дијагностичката точност (DG) беше одредена на пресечните точки (CP) на индексите на абдоминалната дебелина и на индексите на нормална телесна масна дистрибуција (BFD).

Резултати: Вредностите на A/L, Tr/L, Tr/To и L/To DXA-индексите беа високо сигнификантно различни меѓу CS и O_1, како и меѓу O_2 споредено со O_1 и корелираа високо сигнификантно меѓу себе и со BMI, исто така ($p < 0,0001$). A/L-Tm CP од 0,3 најдобро ги диференцираше CS од O_1 за највисока DG од 100 % и A/L-Fm CP од 0,26 ги диференцираше за DG од 94,44 % и сензитивност од 100 %. Вредноста на Al-Tn CP од 0,23 и Al-Fn CP од 0,25 најдобро ги диференцираше CS и C, како и O_2 и C за највисока DG од 100 %.

Заклучок: Вредностите на DXA-индексите A/L, Tr/L, Tr/To и L/To се разликуваа значајно меѓу четирите групи, значајно корелираа меѓу нив и со BMI кај не CS групите и потврдија дека порастот на BMI беше поврзан со поизразена абдоминална BFD. A/L-Tm CP од 0,3 и A/L-Fm CP од 0,26 беа докажани како најдобри дијагностички индекси на екстремна абдоминална дебелина и тие може да се користат, исто така, во докажување на абдоминална BFD кај не CS дебелите жени со MS. Вредностите на A/L-Tn CP од 0,23 и A/L-Fn CP од 0,25 беа докажани како најдобри дијагностички индекси на нормална BFD, кои комплетно ја исклучуваат абдоминалната дебелина.

Клучни зборови: DXA, абдоминална дебелина, индекси на централна дебелина, пресечни точки