The Relationship of Body Fat Ratio to Anthropometric and Metabolic Parameters in Normal Weight and Overweight Women; The Concept of Normal Weight Obesity

Huseyin Nejat Kucukdag[1], Cemil Isik Sonmez[2]

[1]*Department of Family Medicine, Düzce University Faculty of Medicine, Düzce, Türkiye. ORCID iD: 0000-0003-1803-7701. nejatkucukdag@hotmail.com (Corresponding Author)*
[2]*Department of Family Medicine, Düzce University Faculty of Medicine, Düzce, Türkiye. ORCID iD: 0000-0001-7854-3804*

ABSTRACT

Aim: We aimed to underline the importance of "normal weight obesity concept", prevent the overlooking of Normal Weight Obesity patients, administrate their treatments and explain them the risks regarding their future lives along with making emphasis on the necessity of change in polyclinical practices about the subject.

Methods: We selected 200 female patients that were either normal or overweighted for this study. Patients have been divided into 4 groups with respect to their body mass index and body fat percent values. Differences of bioelectrical impedance analysis measurements between the groups, relation of the anthropometric and metabolic parameters and those parameters' inner correlations have been inspected.

Results: Serum levels of fasting plasma glucose, insulin, HOMA-IR, total cholesterol, LDL, triglyceride and TSH were higher in "Normal Weight Obesity" subjects than "Normal Weight Lean" subjects. The mean LDL levels were found to be higher in the Normal Weight Obesity group compared to the other groups and it was found to be statistically significant. Body fat percent was positively correlated to insulin, HOMA-IR, visceral fat rating, waist – hip circumferences, waist to height – hip to height ratios.

Conclusion: The importance of measurement of body fat percent and not to overlook the Normal Weight Obesity patients should be emphasized once more. Therefore, in the primary care, during public screening and polyclinical assessment states, patients should be checked for obesity with not only measuring their weights and heights, but also detection of their detailed body composition.

Keywords: obesity, body fat distribution, waist to height ratio

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Introduction

Obesity, when tried to be explained in a simple way, is an illness that has characteristic symptom of excessive increase in body fat storage (1). Therewithal, since body fat measurement at the policlinic has its own challenges, obesity diagnosis is performed on the basis of Body Mass Index (BMI) calculations (2).

Although classification and diagnosis activities that depend on BMI has practical advantages, they also have some disadvantages too. The body fat percent (BF%) of people that are classified as normal weighted with respect to their BMI values, has not being checked for being higher than normal limits and hence metabolic risks as well as the respective treatments of those people have been determined based solely on BMI. However, there are existing studies which state that even if a person's BMI values can be classified as normal, the increase of BF% can still affect his metabolic parameters (3).

In this case, which the BMI yield a result that can be classified as normal but the BF% is higher than normal, is defined as "normal weight obesity (NWO)" (3). Previous researches have shown that the people with NWO tend to have some anomalies such as higher serum lipid levels, lower HDL, increased insulin resistance and waist/hip ratio when compared to the people, whose both BMI and BF% values are within normal limits (NWL) (4-6). A research that has been performed among American society has indicated that people in NWO group have quadrupled risk of developing metabolic syndrome (MetS) when compared to NWL people (7). Previous researches have stated that NWO, which has a relation to cardiometabolic dysregulation that is independent from BMI and central obesity, is a risk factor for cardiovascular mortality too (8).

Previous researches have indicated that no matter how high specificity (97%) has the BMI above 30 kg/m^2, which is the cut off threshold for obesity, its sensitivity is quite low (42%). This means that it overlooks more than half of the cases with high BF% (9). A research that had been conducted upon the NHANES (The National Health and Nutrition Examination Survey) data have indicated that 24.7% of women and 19.1% of men can be classified as obese if BMI is to be used, whereas these values can be stated as 52.3% and 43.9% respectively if BF% is to be used as the measurement methodology (9). Just like its share among American society, NWO group has a high percentage among the obese people on global scale (10).

This research aims to detect not only the relation of BF% with both anthropometric and metabolic parameters among the normal weighted and over weighted women patients but also underline the concept of NWO's importance. Moreover, preventing the overlooking of NWO patients, administrating their treatments and explaining risks regarding their future lives are also among our purposes, along with emphasizing the necessity of a change in polyclinical practices about the subject.

Methods

Archived files of patients who applied to The Department of Family Medicine, Faculty of Medicine, Duzce University between January 2018 – July 2018, have been inspected for this study and 200 female patients that were either normal or overweighted have been selected. Male patients, patients younger than 18 years old, pregnant patients and patients that have got pacemaker implanted, patients that had been diagnosed with Type 1 or Type 2 Diabetes and using insulin, patients that had been using antihyperlipidemic, patients diagnosed with kidney or liver failure and patients diagnosed with myocardial infarction or had stroke had been excluded.

Patients have been divided into 4 groups with respect to their BMI and BF% values:

1. Normal Weighted Patients with Normal BF%: These people's BMI values are in 18.5 and 24.9 kg/m^2 interval and they have a BF% smaller than 30%. This group has been named as NWL.
2. Normal Weighted Patients with High BF%: Although the BMI values of those people are in between 18.5 and 24.9 kg/m^2, their BF% values are greater than 30%. This group has been named as NWO.

3. Over Weighted Patients with Normal BF%: BMI values of these people are in 25-29.9 kg/m^2 interval while the BF% values are smaller than 30%. This group has been named as OWL.
4. Over Weighted Patients with High BF%: BMI values of these people are in 25-29.9 kg/m^2 interval while the BF% values are higher than 30%. This group has been named as OWO.

Those values regarding to the patients had used and calculated for this study; age, height, weight, BMI, waist (WC) and hip circumferences (HC) and BF% and visceral fat rating (VFR). BF% and VFR were calculated by the Bielectrical Impedance Analysis (BIA) method. In addition to aforementioned values, ALT, AST, total cholesterol (TC), triglyceride (TG), HDL cholesterol, LDL cholesterol, fasting blood glucose (FBG), insulin, TSH, WBC values had measured and calculated as biochemical parameters. Moreover, AST/ALT (De Ritis ratio), waist/height (WHtR), hip/height (HHtR), waist/hip ratios (WHR), insulin resistance indicator HOMA-IR score had been calculated.

Anthropometric measurements and blood tests had been performed before noon and after a fasting period of at least 8 hours. Waist and hip circumference measurements had been carried with inelastic measuring tapes. Waist circumference had been measured between the last rib (costa) and iliac crest, whereas the hip circumference measurement had been performed over the trochanter majors' largest diameter. Height and circumference measurements had been recorded in centimeters.

Differences of Bielectrical Impedance Analysis (BIA) measurements between the groups, relation of the aforementioned anthropometric and metabolic parameters and those parameters' inner correlations have been inspected.

Descriptive statistics regarding to all parameters within this study had been calculated. Kolmogorov-Smirnov and Shapiro Wilk methods had been used for testing the normality of the continuous quantitative variables. One Way ANOVE (post hoc LSD test) and Kruskal-Wallis test (post hoc Dunn test) had been used for comparing quantitative variables between groups. Inner relations of the quantitative variables had been assessed by Pearson and Spearman correlation tests. SPSS software had been used for statistical analysis and $p<0.05$ had been defined as statistical significance threshold.

Results

This study has been conducted upon the archived files of 200 patients that had been classified as useable, according to the criteria defined by the authors. Each one of the groups have 50 patients. Median age of the selected patients has been found to be equal to 30 years (min:18, max:59). The groups do not include a statistically significant difference with respect to patient's age ($p=0.114$).

Median values of waist circumference, hip circumference and HHtR have been found to be increasing from NWL to OWL group and these increasements are statistically significant ($p<0.001$).

Between the groups changes in median values of TC, HDL and TG among lipids, has not been found as statistically significant ($p>0.05$). However, change in LDL means showed statistically significantce ($p=0.008$). It is worth to be noted that LDL cholesterol values of NWO group is higher than the values of OWL and OWO in a statistically significant way ($p=0.005$ and $p=0.002$ respectively) (Table 1).

Average FBG values as well as insulin and HOMA-IR median values have been found out to be increasing from NWL to OWO in a statistically significant way ($p=0.03$, $p<0.001$ and $p<0.001$ respectively). FBG differences between the groups NWL and OWL, NWL and OWO, NWO and OWO have been found out to be statistically significant ($p=0.009$, $p<0.001$ and $p=0.042$ respectively). The changes in insulin and HOMA-IR values have been found out to be statistically significant for the groups NWL and OWL, NWL and OWO, NWO and OWO as well ($p=0.003$, $p<0.001$ and $p=0.001$ for the insulin values while $p=0.001$, $p<0.001$ and $p<0.001$ for the HOMA-IR values respectively).

Statistically significant positive correlations have been found between BMI and VFR ($r=0.616$, $p<0.001$), insulin ($r=0.328$, $p<0.001$), HOMA-IR

(r=0.335, p<0.001). The close to mid-level positive correlation between BMI and BF% has been found out to be worth to note (r=0.455, p<0.001). It has been found that there exists a statistically significant negative correlation between BMI and AST/ALT ratio (r=0.235, p=0.001).

Table 1. Change in biochemical values with respect to groups and their statistical significances

	NWL (n = 50)	NWO (n = 50)	OWL (n = 50)	OWO (n = 50)	*p* value
Age	25.5 (18-48)	30.5 (18-59)	34 (18-56)	31 (18-56)	0.114
Height (cm)	160.5 (147-174)	163 (149-175)	157.5 (147-169)	161 (150-172)	**<0.001**[c,e,g]
Weight (kg)	58.75(46.5-70.7)	64.85 (50.8-73.1)	66.75 (57.1-75.9)	73.15 (58.8-86.3)	**<0.001**[b,c,d,f,g]
BF%	26.55 (10.8-30)	31.65 (30.1-38)	28.65 (23.4-31.1)	36.25 (30-41.9)	**<0.001**[b,d,e,f,g]
VFR	2 (1-5)	4 (2-8)	3 (2-7)	5 (2-9)	**<0.001**[b,c,d,f,g]
WC (cm)	78.62±8.41[y]	81.78±6.77[y]	85.29±7.75[y]	85.9±5.88[y]	**<0.001**[b,c,d,e,f]
HC (cm)	97 (86-106)	101 (82-113)	103 (92-112)	106 (98-116)	**<0.001**[b,c,d,f,g]
WHR	0.81±0.96[y]	0.82±1.01[y]	0.83±0.74[y]	0.81±0.79[y]	0.294
WHtR	0.48 (0.38-0.6)	0.49 (0.4-0.58)	0.54 (0.46-0.64)	0.53 (0.42-0.6)	**<0.001**[c,d,e,f]
HHtR	0.6 (0.55-0.65)	0.62 (0.51-0.68)	0.65 (0.58-0.72)	0.66 (0.59-0.75)	**<0.001**[c,d,e,f]
LDL (mg/dL)	109.76±37.75[y]	121.3±36.93[y]	102.65±27.01[y]	100.21±26.14[y]	**0.008**[e,f]
HDL (mg/dL)	52.65 (35.9-96)	52.85 (34-84)	49.65 (34-87)	53.35 (32-83)	0.728
TG (mg/dL)	74 (38-151)	79 (46-253)	86 (36-514)	78.50 (20-271)	0.217
TC (mg/dL)	174 (112-308)	184 (117-310)	171 (114-251)	171 (112-246)	0.077
AST/ALT	1.41 (0.53-2.79)	1.39 (0.6-2.38)	1.27 (0.73-3.54)	1.25 (0.69-2.52)	**0.017**[d]
FBG (mg/dL)	87.8±7.46[y]	90.07±7.09[y]	91.65±6.53[y]	93.07±8.15[y]	**0.03**[c,d,f]
Insulin (µU/ml)	5.62 (1.68-14.09)	6.56 (1.83-16.33)	8.37 (2.52-20.51)	10.24 (4.2-28.27)	**<0.001**[c,d,f]
HOMA-IR	1.18 (0.29-3.14)	1.43 (0.41-4.34)	1.92 (0.61-4.62)	2.38 (0.93-6.21)	**<0.001**[c,d,f]
QUICKI	0.37 (0.32-0.48)	0.36 (0.31-0.45)	0.35 (0.31-0.42)	0.34 (0.29-0.39)	**<0.001**[c,d,f]
TSH (µU/ml)	1.45 (0.12-4.58)	1.98 (0.05-8.31)	1.84 (0.51-4.5)	1.94 (0.26-22.79)	**0.03**[d]

Statistically Significant Result: a: between all groups, b: between NWL and NWO, c: between NWL and OWL, d: between NWL and OWO, e: between NWO and OWL, f: between NWO and OWO, g: between OWL and OWO. y: mean±standard deviation value (Values without this superscript represent median and min-max values)

Statistically significant correlations have been found between VFR and WC (r=0.460, p<0.001), HC (r=0.470, p<0001), WHtR (r=0.439, p<0.001), HHtR (r=0.447, p<0.001). It has been found that there exists a statistically significant negative correlation between VFR and AST/ALT ratio (r=0.225, p=0.001) (Table 2).

While there was a statistically significant positive correlation between HC and insulin (r=0.256, p<0.001) and between HC and TSH (r=0.242, p=0.001), no statistically significant correlation was found between WC and insulin, and between WC and TSH. However, while there was no statistically significant correlation between HC and TG, a positive correlation was found between WC and TG (r=0.247, p=0.001) (Table 3).

Statistically significant relations between TG and WHtR (r=0.228, p=0.002), AST/ALT ratios (r=-0.201, p=0.005) as well as between HDL and WBC (r=-0.215, p=0.003) in addition to the relations between LDL and insulin (r=-0.220, p=0.002), HOMA-IR (r=-0.215, p=0.003) have been found.

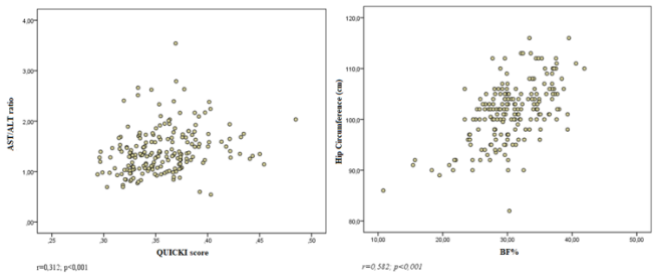
Table 2. Results of statistical correlation between anthropometric and biochemical values

		BMI	BF%	VFR	WC	HC	WHtR	HHtR	WHR
FBG	*r*	0.189	0.183	0.192	**0.295**	**0.262**	**0.272**	**0.224**	0.142
	p	0.007	0.009	0.007	**<0.001**	**<0.001**	**<0.001**	**0.002**	0.05
Insulin	*r*	**0.328**	**0.278**	0.075	0.179	**0.256**	0.021	0.180	-0.044
	p	**<0.001**	**<0.001**	0.293	0.013	**<0.001**	0.264	0.013	0.543
HOMA	*r*	**0.335**	**0.278**	0.098	**0.210**	**0.270**	0.169	**0.220**	0.006
	p	**<0.001**	**<0.001**	0.169	**0.004**	**<0.001**	0.021	**0.002**	0.934
QUICKI	*r*	**-0.335**	**-0.278**	-0.098	**-0.210**	**-0.270**	-0.169	**-0.220**	-0.006
	p	**<0.001**	**<0.001**	0.169	**0.004**	**<0.001**	0.021	**0.002**	0.934
TSH	*r*	0.154	0.148	0.096	0.116	**0.242**	0.136	**0.252**	-0.021
	p	0.030	0.037	0.179	0.112	**0.001**	0.063	**0.001**	0.771
AST/ALT	*r*	**-0.235**	-0.149	**-0.225**	-0.183	-0.122	-0.165	-0.128	-0.096
	p	**0.001**	0.035	**0.001**	0.011	0.093	0.023	0.079	0.187
LDL	*r*	-0.092	0.049	0.158	0.147	-0.031	0.114	-0.070	0.176
	p	0.203	0.492	0.028	0.045	0.676	0.120	0.344	0.016
HDL	*r*	-0.063	-0.076	0.058	-0.067	0.003	-0.061	0.007	-0.081
	p	0.379	0.292	0.420	0.360	0.972	0.169	0.922	0.273
TC	*r*	-0.047	0.075	**0.226**	0.163	0.008	0.020	-0.036	0.160
	p	0.512	0.296	**0.001**	0.026	0.909	0.066	0.627	0.028
TG	*r*	0.161	0.130	**0.295**	**0.247**	0.110	**0.228**	0.109	0.169
	p	0.023	0.069	**<0.001**	**0.001**	0.132	**0.002**	0.136	0.020

Table 3. Inter correlation relations of anthropometric values

		VFR	WC	HC	WHtR	HHtR	WHR
BF%	*r*	**0.668**	**0.382**	**0.582**	**0.277**	**0.400**	0.40
	p	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.585
BMI	*r*	**0.616**	**0.433**	**0.589**	**0.492**	**0.687**	0.086
	p	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.236
VFR	*r*		**0.460**	**0.470**	**0.439**	**0.447**	0.175
	p	-	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.015
WC	*r*			**0.445**		**0.374**	
	p	-	-	**<0.001**	-	**<0.001**	-
HC	*r*				**0.351**		-0.179
	p	-	-	-	**<0.001**	-	0.013

We have found that there exist relations worth noting between FBG and WHtR (r=0.272, p<0.001), HHtR (r=0.224, p=0.002), as well as between insulin value and AST/ALT ratio (r=-0.309, p<0.001), in addition to the relation between HOMA-IR and HHtR (r=0.220, p=0.002), just like the one between TSH and HHtR (r=0.252, p=0.001) (Graphic 1).



Graphic 1. Correlation scatter plots of ALT/AST ratio vs QUICKI score and hip circumference vs BF%Discussion

Median value of VFR has been found out to be significantly higher for OWO group than other groups. Since the OWO group is the one with the highest BMI and BF% values, these finding had been expected indeed. Median value of VFR has been found to be higher for the NWO group than NWL and OWL groups too. However, the difference between NWO and OWL groups has been found as statistically insignificant. This finding can be explained with the higher meaningfulness level of the correlation between VFR and BF% (r=0.668, p<0.001) when compared to the correlation between VFR and BMI (r=0.616,

p<0.001). In fact, Bouchard has stated this finding in one research (11). Hence, BF%'s effect on VFR is greater than the effect of BMI's. Both BMI and BF% values are higher in the NWO group than the NWL group. Thus, difference in the VFR values are within the expected limits. BMI values of the patients in the OWL group are higher than the values regarding to the patients in the NWO group, but this comparison gets reversed when it comes to BF%. Since the effect of BF% on VFR is higher than the effect of BMI, VFR values are higher in NWO group, but this highness is statistically insignificant.

In contrast to existing literature, WHR have not shown any meaningful difference between groups in this study. Most of the researches that has been published indicate that WHR of NWO group should be higher than the ratios regarding to NWL group and overweighed groups have a tendency of having higher WHR than NWO group (6,12,13). Moreover, the researches that had been conducted upon normal weighted people indicate that the WHR increases as focus moves thorough the groups that have higher BF% (9,14). However, researches performed by Miazgovskiet et al. (15) and Karkhaneh et al. (16) indicate, that the WHR does not show a statistically significant difference between NWL and NWO groups as shown in our study. It is worth to note that aforementioned studies have also defined cut off value for BF% as 30%, with selected cases that belong to women patients, which include a smaller number of patients than the other studies which with these aspects are similar to our study. Therefore, although it can be thought that the conflict between the results may depend on the cut off threshold difference, gender factor and patient count that had been included in the research, then it should also be considered that waist and hip circumference values for Turkish people may differ than those of European and American people.

Hip/height ratio tend to increase from NWL group to OWO group but the increase between the NWL and NWO groups in addition to the increase between OWL and OWO groups have not been found as statistically significant. No matter there exists a significant correlation between HHtR and BF% (r=0.400), it is not as high as the correlation between HHtR and BMI (r=0.687). This situation explains the statistically significant and insignificant changes between groups.

HDL cholesterol, TG and TC values have not shown any meaningful difference between the groups in this study. Moreover, the finding of lack of meaningful correlation between lipids and BMI and between lipids and BF% also supports this situation. However, literature has quite different findings about this subject. TC values have been found out to be not indicating any meaningful change between NWO and NWL groups (12,15). When it comes to the HDL, although some articles have stated that there does not exist any meaningful difference in its value between groups, generally its value have been found to be lower in NWO group than in NWL group (6,12,15). TG values have also been found to be higher in NWO group than in NWL group (6,12,15). Two different studies each using four groups that cover NWL, NWO, overweighted people and obese people, have stated that TC and TG values have a tendency of increasing as the focus shifts from NWL group towards the obese groups whereas HDL cholesterol values have been found out to be decreasing during the same process (13,17). In this study, TG and TC values have been found out to be higher in NWO group than in NWL group but this difference can not be categorized as statistically significant. Reason for this insignificancy has been thought as the lack of total number of patients that had been included in the study. Similarly, difference of HDL cholesterol levels between NWO and NWL groups have been found out as being statistically insignificant just like another research that had used cut off threshold for BF% as 30% too (6). The reasons of different findings among other studies have been considered as that studies use different cut off threshold values and difference among the gender of the patients that had been included in those researches.

LDL cholesterol levels have been found out to be higher among NWO group than among other groups. Although it has been found to be higher among NWO group than among NWL group, this highness has been found out as statistically insignificant. Reason of this insignificancy has been thought as lack of patient

count that had been included in the research. In fact, literature research had showed that the LDL cholesterol levels among NWO group has been found to be higher than the levels among the NWL group, except in the studies that had included smaller total patient count (6,12,15). A research that had been conducted by Berg et al. (18) in Sweden, divided the patient files to be used based on their gender and then proceeded by further dividing each group into four subgroups such that those groups cover NWL, NWO, OWL and OWO types like we have done, before searching those groups' relation with cardiovascular risks. Aforementioned study has indicated that LDL cholesterol levels of male patients had been found out to be higher among the NWO group than the other ones. But when it comes to the female patients, while its levels have been found out to be higher among the NWO group than the NWL and FWL groups, OWO group has even higher levels of LDL cholesterol than the NWO group. The reason of the small difference between the findings has been thought as the decision of selecting 35% as the cut off threshold for women.

It is worth noting that the LDL cholesterol levels have been found out to have their peaks among NWO group, independent of BMI and BF%. NWO, in fact as an unexpected body composition, characterized as a situation where the normal weighed people develop high BF%. This unexpected situation can be considered as a reason of both increase but these two situations may be outcome of another sudden factor. Further research should be done on this subject to detect the real reasoning.

The AST/ALT ratio decreased from the NKN group to the FKO group, and the difference between the NKN and FKO groups was statistically significant. Having said that, there exist studies that have indicated that, as a result of weight increase, ALT value tends to increase faster than AST value and hence AST/ALT ratio gets smaller (19). Findings of those aforementioned studies coincide with the findings of this study. The negative correlations between AST/ALT ratio and both BMI and VFR, have also been detected during this study as expected.

It is also worth noting that this study has found negative correlations between AST/ALT ratio and both insulin and insulin resistance (HOMA-IR). In fact, a research conducted with normal weighed people had found that AST/ALT ratio among the insulin resistant population is significantly lower than the population without insulin resistance, which coincides with this study (20).

Fasting blood glucose, insulin and HOMA-IR values increased from the NKN group to the FKO group. Findings of the researches among the literature correlates with the finding of this study. HOMA-IR, insulin and FBG values are higher among the NWO group than among the NWL group in addition to being higher among the over weighted groups than among the NWO group (5,6,12,16). Hence, serum insulin levels and insulin resistance tend to get higher as the weight and body fat increase. Finding of this study about insulin and HOMA-IR values' individual statistically significant relations with BMI and BF% values also support this situation.

The correlation that we have found between BF% and HOMA-IR had also been indicated by the previous researches (21). That relation between the BMI and HOMA-IR has been found out to be stronger in this study and supporting of this finding by the previous researches should not be overlooked (22). Increase in insulin resistance and risk of developing DM along with the weight gain has already been indicated in researches in literature (23). However, it turns out that arising of this relation depends not only on the effect of BF% but also on the effect of other parameters.

Statistically significant positive correlations have also been found between TSH and both WC and HHtR. We had not been encountered with detailed studies explaining this situation during literature research. However, it is known that a correlation between BMI and TSH exists (24). This correlation does not seem unreasonable given that women's weight is gained from the hip region. Having said that, further research should be performed to detect whether the HC is a good indicator of thyroid pathology.

Having found that the correlation between VFR and HC is similar to the one with VFR and WC shows that HC is as important as the WC when it comes to

detecting visceral adiposity among women. Similar findings about this subject can also be found in literature (25).

The correlation between BMI and VFR has been stated by the previous researches and it is also a relation that we had expected to find out. However, Janssen et al. (26) has indicated that although there exists a correlation between BMI and visceral adiposity, even a stronger correlation exists between WC and visceral adiposity. That indication conflicts with the findings of this study and the reason of this conflict is assumed to be because of the inclusion only the normal weighted and overweighted people where as in the study of Janssen et al. (26) they included an obese group.

It is also important that the WHR does not have a correlation with anthropometric and metabolic parameters including BMI. A research that has been conducted upon Turkish people has also stated that the relation between WHR of women and the illnesses like DM, HT, HL or obesity is statistically insignificant (27). However, a research that had been performed outside of Turkey has indicated a correlation between WHR and BMI among women, although that correlation is stronger for men (28). This situation is thought to be caused by the fact that this study's population consists of normal and overweighted Turkish women. Widespread further researches among Turkish society should be performed to enlighten this subject.

Although there exist correlations between VFR and both TC and TG, a relation like this have not been observed between VFR and either HDL or LDL. A similar finding between visceral adiposity and serum lipids had been indicated by a research performed by Banerji et al. (29).

The correlation between WC, HC and FBG, insulin, HOMA-IR is an information that had already been written in the literature. Findings of this study indicates that the correlation between HOMA-IR and HC is slightly stronger than the one with the WC. A research performed on the male population has indicated that although the relation between HOMA-IR and WC is slightly stronger, there also exists a relation between HC and insulin resistance (22).

Statistically significant positive correlations between TG and both WC and WHtR have been found. Existing researches in the literature also support this finding. Correlation between the TG and WC is valid for both men and women.

The correlations that we have found between the LDL and both insulin and HOMA-IR, indicated in further researches that some sub fractions of LDL is also related with insulin resistance (30).

It has been found that important metabolic parameters such as FBG, insulin, HOMA-IR, TC, LDL, TG, TSH are higher among the NWO group than among the NWL group. However, no statistically significance has been found possibly due to the low number of patients. In addition to this, the mean LDL levels peaked in the NKO group compared to the other groups, and it was found to be statistically significantly higher.

We found out that BF% have positively correlated with insulin level, HOMA-IR score, VFR, WC, HC, WHtR and HHtR whereas it does not show correlation with TC, TG, LDL and HDL cholesterol levels in a statistically significant way.

Conclusion

In the light of the findings mentioned above, the importance of measurement of BF% and not overlooking the NWO patients should be emphasized once more. Therefore, in the primary care, during public screening and polyclinical assessment states, patients should be evaluated for obesity with not only measuring their weights and heights, but also with the detection of their detailed body composition.

Moreover, we advise that further widespread epidemiologic researches should be performed at both international and national level to reach a consensus about literature wise widely accepted cut off threshold value for BF% that can be affected by many parameters such as age, gender and race of the patient group.

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