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Comparative Characteristics Of Body Composition In Obesity Phenotypes

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Abstract

Aim: to study bioimpedance parameters of Uzbek women of childbearing age suffering from metabolically healthy and metabolically complicated obesity, to study their correlation with the degree of obesity and some biological markers.

Materials and methods of research. The study was conducted with the participation of the BERNICA project of the International Educational Grant ERASMUS+. The study was conducted in 2022-2023. It was attended by 224 obese women and 45 practically healthy women of childbearing age who are registered in family polyclinics in Tashkent.

Results: It was noted that the fat mass in the 1st group of the study was higher than in the 2nd group, as well as in both groups more than in the control group. It was found that lean body mass was higher in group 2 compared to group 1, and the total volume of body fluid was maximal in group 1. Also, in the MCO group, a strong positive correlation was found between the ratio of BF/HR, BP, IVO, total IVO fluid volume, total and extracellular fluid volumes, as well as the percentage of active cell mass with the percentage of skeletal muscle mass.

There was a strong positive correlation of fat mass with periprandial and postprandial glucose. In the MSS group, the BF/HR ratio positively correlated with blood pressure and extracellular fluid volume, less correlated with carbohydrate metabolism, but a weaker correlation was found between it and fat mass than in the MCO group. In both groups, fat mass positively correlated with serum leptin and insulin levels, as well as insulin resistance, and this process was more pronounced in the group of metabolically complicated obesity.

Conclusion: Based on the results obtained, it was found that in obese Uzbek women of fertile age, with both phenotypes, an increase in the proportion of body fat is consistent with impaired carbohydrate metabolism in the body, hypertension and increased insulin resistance, and this process was clearly visible in women with metabolically complicated obesity.

Key words: obesity, bioimpedance measurement, carbohydrate metabolism, leptin, insulin.

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Резюме

Мақсад: Ўзбек миллатига мансуб туғруқ ёшидаги аёлларда соғлом ва метаболик асоратланган семизликнинг биоимпедансометрик жиҳатларини ўрганиш, уни семизлик даражаси ва айрим биологик маркерлар билан ўзаро боғлиқлигини ўрганиш иборатдир.

Тадқиқот материал ва усуллари. Тадқиқот Европа Иттифоқи халқаро ERASMUS+ таълим грантининг "BERNICA" лойиҳаси иштирокида амалга оширилди. Тадқиқотга 2022-2023 йилларда Тошкент шаҳар оилавий поликлиникаларида ҳисобда турувчи ўзбек миллатига мансуб, фертил ёшдаги 224 нафар семизлик аниқланган ва 45 нафар амалий соғлом (назорат гуруҳи) аёллар жалб этилди.

Натижалар: Тадқиқотнинг 1-гуруҳида ёғ вазни 2-гуруҳи кўрсаткичидан кўплиги, иккала гуруҳдаги ёғ вазни назорат гуруҳига нисбатан ошганлиги қайд этилди. Юқа вазни 2-гуруҳда 1-гуруҳга нисбатан кўпроқлиги, организмдаги умумий суюқлик ҳажми эса 1-гуруҳда бошқаларга нисбатан ошганлиги аниқланди.

Шунингдек, МАС гуруҳида ЁВ\БА нисбати АҚБ, ВСИ, умумий суюқлик хажмиВСИ (r=0,74; p<0,001), умумий ва экстрацеллюляр суюқлик ҳажмлари ўртасида кучли мусбат, фаол хужайралар вазни улуши скелет–мушак вазни улуши билан манфий корреляция аниқланди. Ёғ вазнини перипрандиал ва постпрандиал глюкоза билан кучли мусбат корреляцион боғлиқлиги қайд этилди.

МСС гуруҳида ЁВ\БА нисбати ДАБ ва экстрацелюлляр суюқлик ҳажми билан ўзаро мусбат, лекин углеводлар метаболизми меъёрида бўлсада, у билан ёғ вазни ўртасида МАС гуруҳига нисбатан кучсизроқ корреляцион боғлиқлик аниқланди. Иккала гуруҳида ҳам ёғ вазнини қон зардобидаги лептин ва инсулин миқдори ҳамда инсулинга резистентлик ҳолати билан ишонарли мусбат корреляцион боғлиқлиги аниқланди ва бу жараён метаболик асоратланган семизлик гуруҳида яққол намоён бўлди

Хулоса: Олинган натижаларга кўра, ўзбек миллатига мансуб фертил ёшдаги аёлларда соғлом ва метаболик асоратланган семизликнинг хар иккала фенотипида ҳам тананинг ёғ вазни улушини ошиши организмда углевод алмашинувини бузилиши, артериал гипертензия ҳамда инсулинга резистентлик ҳолатини кучайиши билан ҳамоҳанглиги маълум бўлди ва бу жараён 1-гуруҳ - метаболик асоратланган семизлик аниқланган аёлларда яққол кўзга ташланди.

Калит сўзлар: семизлик, биоимпедансометрия, углевод алмашинуви, лептин, инсулин

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Резюме

Цель: изучить биоимпедансометрические показатели женщин детородного возраста узбекской национальности, страдающих метаболически здоровым и метаболически осложненным ожирениями, изучить их корреляцию со степенью ожирения и некоторыми биологическими маркерами.

Материалы и методы исследования. Исследование проведено при участии проекта «BERNICA» Международного образовательного гранта ERASMUS+. Исследование проводилось в 2022-2023 годах. В нем принимали участие 224 женщины с ожирением и 45 практически здоровых женщин детородного возраста, состоящих на учете в семейных поликлиниках города Ташкента.

Результаты: Было отмечено, что жировая масса в 1-й группе исследования была больше, чем во 2-й группе, а также в обеих группах больше по сравнению с контрольной группой. Было установлено, что тощая масса была выше во 2-группе по сравнению с 1-группой, а общий объем жидкости в организме был максимален в 1-группе. Также в группе МОО была обнаружена сильная положительная корреляция между соотношением ЖМ/ОТ АД, ИВО, общим объемом жидкости ИВО, объемами общей и внеклеточной жидкости, а также процентом массы активных клеток с процентом массы скелетных мышц. Отмечена сильная положительная корреляция жировой массы с перипрандиальной и постпрандиальной глюкозой. В группе MSS соотношение ЖМ/ОТ положительно коррелировало с АД и объемом внеклеточной жидкости, меньше коррелировало углеводным обменом, однако между ним и жировой массой была обнаружена более слабая корреляция, чем в группе МОО. В обеих группах жировая масса положительно коррелировала с уровнем лептина и инсулина в сыворотке крови, а также инсулинорезистентностью, причем этот процесс был более выражен в группе метаболически осложненного ожирения.

Заключение: По полученным результатам установлено, что у узбекских женщин фертильного возраста, больных ожирением, при обоих фенотипах увеличение доли жировой массы тела согласуется с нарушением углеводного обмена в организме, артериальной гипертензией и повышением инсулинорезистентности и этот процесс был отчетливо виден у женщин с метаболически осложненным ожирением.

Ключевые слова: ожирение, биоимпедансометрия, углеводный обмен, лептин, инсулин.

According to official data, the prevalence of obesity in the world over the past 40 years has increased by 2 times among women and 3 times in men, as well as an increase in the body weight index of 0.59 in women and 0.63 kg/m^2 in men every 10 years [13.18]. Regardless of the definition of obesity, it is one of the components of the metabolic syndrome, with the participation of which the likelihood of developing CVD increases by 23%, and the occurrence of DM increases by 44%. This is caused by a decrease in insulin sensitivity of tissues caused by a slow inflammatory process in the body and dyslipidemia [12, 14,19,23,26]. The development of obesity is caused by genetic predisposition, malnutrition, hypodynamics, arterial hypertension (AH), stress, dysgormonal changes, including esterogen deficiency and increased testosterone levels in women, and decreased testosterone levels in men. Also, obesity of the abdominal type is most common in population, which is often accompanied by hormonal and metabolic changes [1]. It is known that in metabolic syndrome (MS) there is an increase in the volume of visceral adipose tissue (VAT), a decrease in the sensitivity of peripheral tissues to insulin and a violation of carbohydrate, lipid and purine metabolism in the body as a result of hyperinsulinemia, as well as an increase in hypertension. MS occurs in 20-25% of the adult population living in developed countries, and this rate is increasing year by year. It is accompanied by subclinical damage to vital organs, in particular, a decrease in the property of filtering the kidneys, microalbuminuria, endothelial dysfunction, increased arterial stiffness, left ventricular dysfunction and hypertrophy, thickening of the wall of the sleeping artery, fatty hepatosis of the liver or the development of non-alcoholic steatogepatitis [15,16]. In exchange for an increase in the volume of VAT in MS, there is also a violation of the functioning of the reproductive system in men and women as a result of changes in the endocrine system [17,24]. The above-mentioned changes are a reversible process, the premature detection and implementation of measures to eliminate them will lead to an improvement in the clinical condition of patients

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and the quality of life. However, overweight or obesity is not present in all patients who have been diagnosed with metabolic disorders, including changes in blood pressure in the area of lipid and carbohydrate metabolism. Such patients belong to the group of metabolically healthy obesity (MHO) [6]. To date, there are about 30 definitions of MHO for which a single set of criteria for its diagnosis has not been developed. This group includes patients who, in addition to obesity, have no more than one criterion for multiple sclerosis or who have preserved tissue sensitivity to insulin, and there are no cardiometabolic risk factors. It has also been suggested in some studies that serum S-reactive protein, low-density lipoproteins, leukocyte, glycated hemoglobin, fibrinogen, and the waist–hip ratio should be determined as additional criteria in addition to the above symptoms in diagnosing MHO [20,21]. Regardless of the study population, MCO is more common in women than in men, and this difference tends to decrease with age. [17,25]. In a number of studies, opinions about MHO are contradictory, arguing that there is no correlation between it and the safety of the development of CVD and DM [2,3], while another group of scientific studies substantiates obesity on the grounds that this phenotype is not stationary, it is an intermediate stage of physiological healthy development and obesity, leading to the development of MS in future [4,9,11, 22]. It was also noted in studies that the volume of VAT in the body, and not BMI, directly increases the risk of CVD and death [5,10]. In MHO, the structure and size of adipose tissue is different from metabolic complication obesity, in which the volume of VAT is 50% less, and the size of adipocytes is 15% smaller [23].

The distribution of adipose tissue in the body according to the android or gynoid type and the level of cardiometabolic risk directly depend on the activity of sex hormones. In particular, in the postmenopausal period, the amount of estrogen in women decreases sharply, but the production of androgenic hormones in the adrenal glands persists. This causes the development of metabolic disorders, i.e. an increase in VAT volume production and an increase in cardiometabolic risk factors. And in men, these changes are accompanied by a lack of testosterone. [8].

Therefore, the continuation of scientific research on the full-fledged study of the pathophysiology of overweight and obesity, determining their relationship with gender identity and cardiometabolic risk factors is relevant in modern medicine.

The aim of the study is to study the bioimpedance aspects of healthy and metabolically complicated obesity in women of fertile age of Uzbek nationality, to study it depending on the level of obesity and certain biological markers..

Material and methods of research. The study was carried out with the participation of the international project of the European Union International ERASMUS+ educational grant "BERNICA" (increasing educational and research capacity in the field of nutriciology and Dietology in Central Asian countries). The study involved 224 Uzbek women of fertile age who are registered in family polyclinics in the city of Tashkent 2022-2023 years, who are obese and 45 practically healthy (control group) women.

The study was conducted by simple and random selection. The following criteria were met when participating in the study: women aged 15-49 years, body mass index (BMI) $\geq$ 30 kg/m^2, waist ratio (WR) > 80 cm, arterial hypertension (AH) stages I-II, absence of clinical signs of insulin resistance and kidney damage, as well as written consent to participate in the study. The diagnosis of AH was made on the basis of the criteria of the European AH Society (2018) and the Russian Medical Society on AH (2019).

The observed women were classified into 2 groups according to the above examinations and metabolic syndrome criteria (WHO, 2016; International diabetic Federation, 2009), with 133 women diagnosed with metabolically complicated obesity (MCO) with an average age of 42.0±0.5; Group 2 was made up of 91 women diagnosed with metabolically healthy obesity (MHO) with an average age of 41.7±0.7. The control group consisted of 45 healthy volunteer individuals (females, average age 43.2±0.8, BMI<30 kg/m^2, waist circumference less than 80 cm). While BMI was 37.4±0.3 in group 1, 35.7±0.3 kg/m^2 in group 2 (r<0.001), I stage of obesity was 34.6% (46 individuals) in group 1, 48.4% (44 individuals) in group 2, its II stage was 33.8% (45 individuals) in group 1, 28.6% (26 individuals) in group 2 (r<0.01), and III level was 31.6% (r<0.01) in group 1 42), in group 2, 23.0% (21) (r < 0.001) were recorded in women. AH I level were found in 52.7% (70 individuals) of Group 1 and AH II level were found in 47.3% (63 individuals), with AH duration averaging 3.2±1.3 years.

Also in the groups involved in the study were the general and biochemical blood count found, serum leptin, insulin, HOMA-IR, peri - and postprandial glucose levels.

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In statistical processing of the data obtained in the study, MS Excel (2016) used a packaged computer program. Correlation was conducted by applying the taxable Pearson correlation coefficient and determining its significance based on reliability tables.

Research results and their discussion. It is known that when a body is called a composite composition, it means its fat–free tissue - muscles, bones and internal organs, as well as the mass of adipose tissue. An increase in the mass of adipose tissue and a decrease in the mass of fat-free tissues-active cells indicate a violation of the body's energy balance, carbohydrate and lipid metabolism, and an increased risk of CVD. Based on this, when studying the body composition in the groups participating in the study, the following was found (Table 1). In the 1st group of the study, the fat content was 41.3±0.5 kg, which is 1.12 times more than in the 2nd group, which is 3.4% more ($p<0.001$), indicating an increase in fat content in both groups compared with the control group ($p<0.001$).

1-table

Comparative characteristics of body composition in groups

Index	1- group (n=133)	2- group (n=91)	Control group (n=45)	Reliability of indicator difference in groups, p
Fat, kg	41,3±0,5	36,6±0,6	16,2±0,3	P_{1-2} <0,001 P_{1-3}<0,001 P_{2-3}<0,001
Share of fat, %	42,8±0,3	39,4±0,4	24,7±0,4	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}<0,001
Lean body mass	54,4±0,4	56,1±0,6	49,6±0,7	P_{1-2}<0,05 P_{1-3}<0,001 P_{2-3}<0,001
Active cell weight, kg	28,3±0,2	31,3±0,5	27,8±0,3	P_{1-2}<0,001 P_{1-3}>0,05 P_{2-3}<0,001
Percentage of active cell weight, %	52,0±0,1	56,0±0,8	56,1±0,2	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}>0,05
Skeletal muscle weight, kg	21,9±0,2	26,2±0,7	23,3±0,3	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}<0,001
Skeletal muscle weight share, %	40,2±0,2	46,5±1,0	47,1±0,2	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}>0,05
Total fluid volume, kg	40,4±0,3	36,8±0,4	35,2±0,5	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}<0,05
Extracellular fluid volume, kg	17,9±0,2	15,4±0,2	14,1±0,2	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}<0,001
Intracellular fluid volume, kg	22,5±0,2	21,4±0,2	21,1±0,3	P_{1-2}<0,001 P_{1-3}<0,001 P_{2-3}>0,05

The weight of the lean body mass depends on the body's interstitial structure, and this indicator was 54.4±0.4 kg (56.6%) in group 1, and 56.1±0.6 kg (60.5%) in Group 2 ($p<0.05$). A convincing difference between active cell weight and skeletal-muscle weight share in group 2 and control group was not found, but

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these indicators were observed to have a convincing decrease in group 1 compared to Group 2 (r<0.001). This condition means that physical movements are limited (inactivity), and energy costs are reduced. It was also known that in group 1, the total volume of fluid in the body was 40.4±0.3 kg, which increased mainly due to fluid outside the cell. Extracellular fluid informs about a latent tumor, excess fluid is retained in the body, and this indicator is recorded in group 1 as the total amount of fluid in the body equal to 44.3; in group 2 - as 41.8 and in the control group - as 40.0%.

Also, in the metabolically complicated obesity group, the body has fat with waist ratio (r=0.81; r<0.001), waist-hip ratio (r=0.76; r<0.001), SAP (r=0.83; r<0.001), DAP (r=0.77; r<0.001), VOI (r=0.74; r<0.001), total fluid volume (r=0.70; r<0.001), strongly positive among extracellular fluid volume (r=0.66; r<0.001), a convincing negative correlation relationship with the proportion of active cells weight (r=-0.36; r<0.01), the proportion of skeletal – muscle weight (r=-0.69; r<0.001), implying the energetic activity of the organism. In this group, the extracellular fluid volume, which is considered a latent edema sign, is determined by the waist/hip ratio (r=0.69; r<0.001), VOI (r=0.62; r<0.001), SAP, and DAP (r=0.57 and r=0.55; r<0.001) with the proportion of positive, active cells weight (r=-0.51; r<0.001) correlation dependence was noted. The correct proportionality of fat in the body with the risk of metabolic disorders has been highlighted in studies [23,35,176,246], in the MCO group involved in our observation, these data were once again confirmed. In particular, it has been noted that fatty acid is strongly positive with periprandial and postprandial glucose (r=0.77; r=0.74; r<0.001), general TG, LDL (r=0.67; r=0.72; r=0.59; r<0.001), and weakly negative correlation with HDL (r= - 0.17; r<0.05). Also, an increase in body fat was accompanied by a violation of uric acid metabolism (r=0.71; r<0.001). In the MHO group, it was found that the body correlates positively with the waist/hip ratio (r=0.69; r<0.001), DAP (r=0.52; r<0.001), and extracellular fluid volume (r=0.22; r<0.05). Although carbohydrate and lipid metabolism is in moderation in this group, a weaker correlation relationship between them and fat has been found compared to the MCO group. In the groups involved in the study, the following were found when it was analyzed that fat metabolism correlates with hormonal disruptions related to adipose tissue (Table 2). In both study groups, fat was found to be associated with a strong positive correlation with serum leptin and insulin levels and insulin resistance status, and this process was evident in the obese group with metabolic complications (r<0.001).

2-table

The relationship of fatty acids in obesity phenotypes with hormonal disruptions associated with adipose tissue

Index	Metabolic complication obesity group n=133	Metabolic healthy obesity group n=91
Leptin, ng / ml	0,68*	0,51*
Insulin, μIU/ml	0,74*	0,67*
HOMA-IR, unity	0,81*	0,67*

Note: * - indicator difference reliability, p<0.001.

Conclusion. Judging by the results obtained in both phenotypes of healthy and metabolically complicated obesity in women of fertile age of Uzbek nationality – metabolic healthy obesity and increased fat share of the body in metabolically complicated obesity-it was known that the violation of carbohydrate and lipid metabolism in the body, arterial hypertension and increased insulin resistance, and this process was evident in women who were diagnosed in women of 1st - metabolic group.

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