DOI: 10.5455/msm.2025.37.11-17
Received: Jan 26 2025; Accepted: Mar 02, 2025

ORIGINAL PAPER **Mater Sociomed. 2025; 37(1): 11-17**

Anthropometric Data by Using Bioelectrical Analysis as a Parameters for New Classification and Definition of Obesity

Nizama Salihefendic[1,2], Muharem Zildzic[1,3], Izet Masic[2,3,4], Slobodan M. Jankovic[3,5]

[1]Polyclinic „MedicusA", Gracanica, Gracanica, Bosnia and Herzegovina
[2]Bosanska akademija nauka „Kulin ban", Sarajevo, Bosnia and Herzegovina
[3]Academy of Medical Sciences in Bosnia and Herzegovina
[4]Department for Family Medicine, Faculty of Medicine, University of Sarajevo, Sarajevo, Bosnia and Herzegovina
[5]Faculty of Health Sciences, Kragujevac, Kragujevac, Serbia

Corresponding author: Prof. Nizama Salihefendic, MD, PhD. Polyclinic „MedicusA", Gracanica, Gracanica, Bosnia and Herzegovina. Email: medicus@bih.net.ba. ORCID ID: http//www.orcid.org(0000-0000-0000-0000.

ABSTRACT
Background: The prevalence of obesity and obesity-related clinical conditions, including metabolic-associated steatotic liver disease (MASLD), sarcopenia, and a wide spectrum of pathological manifestations, is rising globally. According to WHO, BMI is the only anthropometric measure currently used to classify obesity, overweight, and underweight. However, emerging research suggests that obesity is a complex pathological state influenced by multiple etiological factors. Given the limitations of BMI, there is a growing need for a more comprehensive assessment of body composition, particularly fat mass quantity and distribution. Bioelectrical impedance analysis (BIA) provides valuable anthropometric data that can help differentiate obesity phenotypes and guide improved therapeutic approaches. **Objective:** This study aims to analyze body composition using BIA in a randomly selected sample of adults from primary healthcare settings in Bosnia and Herzegovina. The primary goal is to assess total body weight, fat mass quantity, fat distribution, and obesity types prevalent in this population. Additionally, the study seeks to establish reference values for further diagnostic, preventive, and therapeutic strategies to improve public health outcomes. **Methods:** A cross-sectional study was conducted on adults (≥18 years) in Gračanica, Bosnia & Herzegovina (B6H), from January 2021 to January 2025. Inclusion criteria required participants to provide signed informed consent, while exclusion criteria included acute systemic diseases, severe dehydration, and fasting for more than 24 hours. Anthropometric parameters measured included age, height, weight, BMI, body fat mass (BFM), fat-free mass (FFM), percent body fat (PBF), waist-hip ratio (WHR), and bone mineral content (BMC). Data were analyzed using SPSS (version 18), with results presented as medians, interquartile ranges, and percentiles (5th, 25th, 50th, 75th, and 95th). **Results:** A total of 4,628 adults participated in the study, of whom 2,824 (61.0%) were female and 1,804 (39.0%) were male. The median age was 45 years (IQR: 29 years). The findings revealed that over one-quarter of the B&H population is obese, with abdominal obesity being the predominant type. This phenotype is associated with the highest risk for metabolic syndrome and MASLD. **Conclusion:** Our study highlights a high prevalence of obesity among the examined individuals in primary care settings in B&H, with abdominal obesity being the most common type. This phenotype is strongly associated with metabolic complications. BIA-derived parameters of fat distribution and visceral fat mass may serve as valuable tools for improving obesity classification and developing more effective preventive and therapeutic strategies.

Keywords: Obesity, Bosnia and Herzegovina, Bioelectrical Impedance Analysis, Adipose Tissue, Clinical Obesity.

1. BACKGROUND

Obesity and its prevalence according to WHO guidelines

The prevalence of obesity and its associated clinical conditions, including metabolic-associated steatotic liver disease (MASLD), sarcopenia, and a wide range of other chronic non-communicable diseases, is steadily increasing worldwide (1, 2). The World Health Organization (WHO) has recognized obesity as one of the greatest threats to global health. According to WHO data from 2022, 2.5 billion adults worldwide were overweight, including 890 million classified as obese (1, 2). This means that 43% of the adult population had excess weight, while 16% were obese. A more recent study published in The Lancet in 2024 further highlighted the growing concern, reporting that over one billion people globally now live with obesity, equivalent to one in every eight individuals These concerning trends emphasize the urgent need for comprehensive preventive and therapeutic measures.

Furthermore, the 21st century has seen a dramatic rise in childhood obesity, reaching epidemic proportions and raising concerns about the early onset of metabolic complications (3, 4). Despite epidemiological studies showing that one in eight people worldwide is affected by obesity and its consequences, there is still no unified global strategy for its diagnosis, prevention, and treatment. The growing prevalence indicates that obesity has reached a critical threshold, highlighting the urgent need for changes in preventive and therapeutic approaches (3-5).

Etiopathogenesis of obesity and its accompanying clinical syndromes

New discoveries in energy homeostasis regulation suggest that multiple organ systems contribute to the pathogenesis of obesity. The brain, gastrointestinal tract, visceral adipose tissue, and liver play crucial roles, resulting in distinct obesity phenotypes. Certain types of obesity are strongly associated with metabolic disorders and the development of almost all chronic non-communicable diseases (4-6).

Obesity is now defined as a chronic, complex pathological condition caused by various etiological factors. A new evidence-based definition differentiates clinical obesity, characterized by increased body weight and fat mass with metabolic disturbances, from preclinical obesity, which is associated with increased body weight but without organ dysfunction or daily activity limitations (5). Insulin resistance is the earliest metabolic disorder leading to metabolic syndrome and MASLD (4, 9). If preventive and early therapeutic measures fail, clinical obesity progresses, resulting in severe chronic diseases and advanced liver cirrhosis, which has become one of the leading indications for liver transplantation (6, 7).

Diagnostic parameters for distinguishing obesity

In clinical practice, Body Mass Index (BMI) is often the sole parameter used to classify obesity, overweight, and underweight. However, BMI cannot distinguish between preclinical and clinical obesity or accurately reflect an individual's health profile (5). Given the limited effectiveness of traditional treatment strategies focusing on lifestyle modifications (diet and physical activity), a new approach is required to facilitate early recognition of clinical obesity and implement specific preventive and therapeutic interventions.

To improve diagnostic accuracy, it is essential to assess obesity type and risk factors associated with clinical obesity. Due to the limitations of BMI, a more comprehensive analysis of body tissue structure and function is now recommended. This includes evaluating key organs involved in appetite regulation, food intake, nutrient absorption, energy expenditure, and fat storage. The quantity and distribution of fat mass play a pivotal role in obesity-related diseases, making these parameters critical for obesity classification and management (5-8).

Anatomical, histological and functional characteristics of adipose tissue

Excessive energy accumulation in the body leads to an abnormal increase in fat mass (4-8). While total fat mass is the primary factor in obesity, adipose tissue exhibits diverse anatomical, histological, and functional properties, which influence its role in clinical obesity development.

Adipose tissue is broadly classified into brown adipose tissue (BAT) and white adipose tissue (WAT). WAT, which comprises the majority of body fat, can be further categorized into subcutaneous fat and visceral fat. Among these, visceral adipose tissue (VAT)—predominantly located in the abdominal cavity—has the most significant impact on metabolic and cardiovascular health. The factors determining fat mass quantity and distribution are among the most critical parameters in obesity classification.

Several methods exist for assessing VAT quantity and distribution, including anthropometric measurements and complete body composition analysis (8, 9, 11, 12). These parameters, combined with clinical evaluation, can serve as standard indicators of clinical obesity (8, 9).

Anthropometric methods for estimating the amount and distribution of adipose tissue

Various methods are available for evaluating VAT levels. The most commonly used anthropometric index in clinical practice is the Waist-Hip Ratio (WHR), which correlates with insulin resistance and cardiovascular disease risk. More precise techniques include imaging modalities that assess body composition in detail (muscle, bone, water, protein, and minerals) using ultrasound, bioelectrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), computed tomography (CT), and magnetic resonance imaging (MRI). Among these, CT is considered the gold standard for visceral fat assessment (8, 9, 11, 12, 13).

BIA provides similar results to CT and is widely applicable in primary healthcare settings due to its ease of use and non-invasive nature. This method measures bioelectrical conductivity through different tissues and can be repeated multiple times to track therapeutic outcomes (8-13). Most tissue structure parameters obtained via BIA primarily reflect visceral fat quantity and distribution.

Mesenteric fat, in particular, plays a crucial role in

Parameter	Median	Interquartile range	5% percentile	25% percentile	50% percentile	75% percentile	95% percentile
Height (cm)	168.0	15.0	154.0	162.0	168.0	177.0	188.0
Weight (kg)	81.2	29.5	48.1	65.6	80.7	95.1	117.8
BMI	28.0	9.3	17.6	23.2	28.0	32.5	39.1
BFM (kg)	26.5	19.6	7.3	16.7	26.5	36.3	51.2
FFM (kg)	50.8	18.8	36.6	44.1	50.8	62.9	78.9
PBF (%)	33.0	16.9	13.6	24.0	33.0	40.9	50.4
WHR	0.98	0.15	0.81	0.90	0.98	1.05	1.14
BMC (kg)	2.9	1.0	2.1	2.5	2.9	3.5	4.5

Table 1. Anthropometric parameters for the study sample (n = 4,628). Abbreviations: Body Mass Index (BMI), Body Fat Mass (BFM), Fat Free Mass (FFM), Percent Body Fat (PBF), Waist-Hip Ratio (WHP), Bone Mineral Content (BMC).

Number of patients	Average VFA (cm^2)	Female	Average VFA (cm^2)	Male	Average VFA (cm^2)	Age 50	Average VFA (cm^2)	Age > 50	Average VFA (cm^2
4628	134,35	2824	145,84	1804	116,36	2649	116,22	1979	158.6

Table 2. Visceral fat area (VFA)

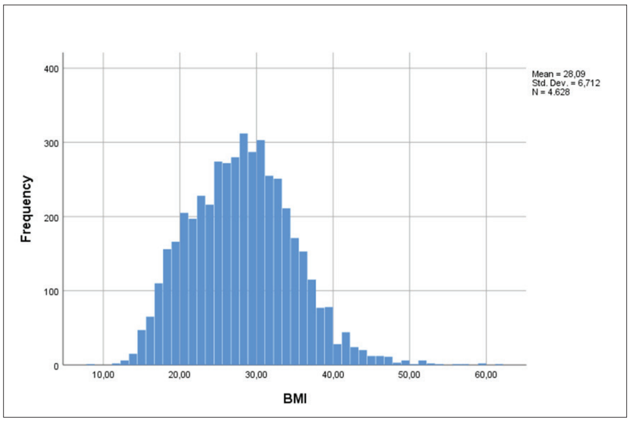

Figure 1. Histogram of the BMI (n = 4,628).

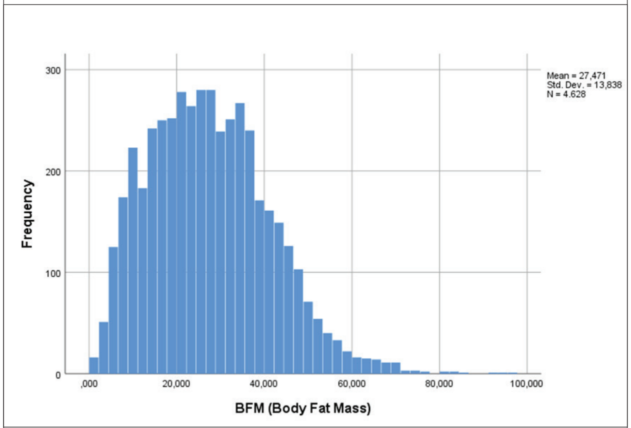

Figure 2. Histogram of the Body Fat Mass (BFM) (n = 4,628).

energy homeostasis by mediating communication along the gut-brain-liver axis, leading some researchers to consider it a distinct metabolic organ (10, 13, 14).

The simplest and most widely applicable method in routine clinical practice is BIA, as it is non-invasive, easy to perform, radiation-free, and suitable for repeated measurements to assess treatment effects. Given the limitations of BMI, bioelectrical impedance represents a valuable tool for differentiating obesity phenotypes and guiding personalized treatment strategies. By assessing body composition, fat distribution, and metabolic risk factors, BIA enables a more precise classification of obesity, supporting the development of targeted prevention and intervention programs (8, 9, 11, 12).

2. OBJECTIVE

In a random sample of family medicine patients, older than 18 years of age, to determine the tissue structure using the bioelectrical impedance method with a special focus on the amount and distribution of adipose tissue. The main goal is to determine the types of obesity that is characteristic to the population in Bosnia and Herzegovina by analyzing these parameters related to total weight, amount, type and distribution of adipose tissue. The next goal is to determine the standards for further diagnostic, preventive and therapeutic procedures for the purpose of general improvement of this population healthstatus.

3. MATERIAL AND METHODS

A cross-sectional study was conducted on adults (≥18 years) in Gračanica, Bosnia & Herzegovina, from January 2021 to January 2025. Inclusion criteria required participants to provide signed informed consent, while exclusion criteria included acute systemic diseases, severe dehydration, and fasting for more than 24 hours. Anthropometric parameters measured included age, height, weight, BMI, body fat mass (BFM), fat-free mass (FFM), percent body fat (PBF), waist-hip ratio (WHR), and bone mineral content (BMC). Data were analyzed using SPSS (version 18), with results presented as medians, interquartile ranges, and percentiles (5th, 25th, 50th, 75th, and 95th). Normality of data distribution was tested using the Kolmogorov-Smirnov test.

4. RESULTS

In total 4,628 adults were enrolled, and all of them completed the study protocol. There were 2,824 females (61.0%) and 1,804 males (39.0%). Median age of the study subjects was 45.0 years, and interquartile range 29.0 years. The parameters listed below were used to assess body structure.

The anthropometric parameters of the study sample for body composition are shown in the Table 1.

TTo assess the presence and type of obesity, key

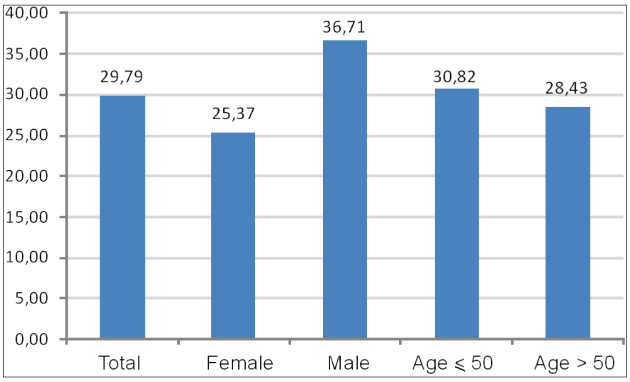

Figure 3. Chart of average values of Skeletal Muscle Mass (SMM) (n = 4,628).

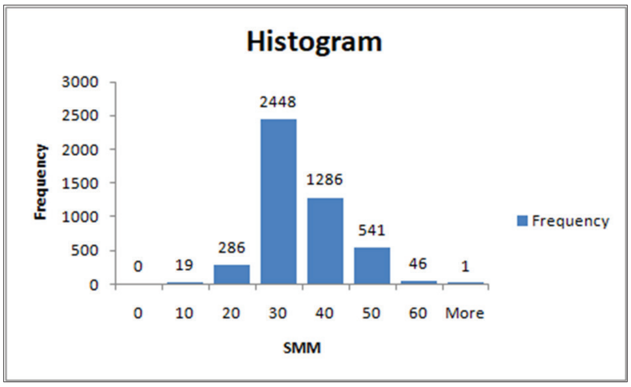

Figure 4. Histogram of the Skeletal Muscle Mass (SMM) (n = 4,628).

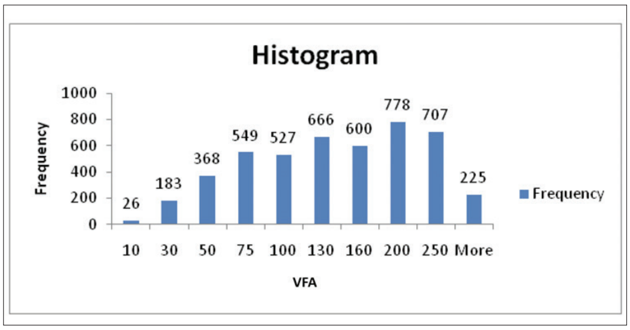

Figure 5. Histogram of the Visceral Fat Area (VFA) (n = 4,628).

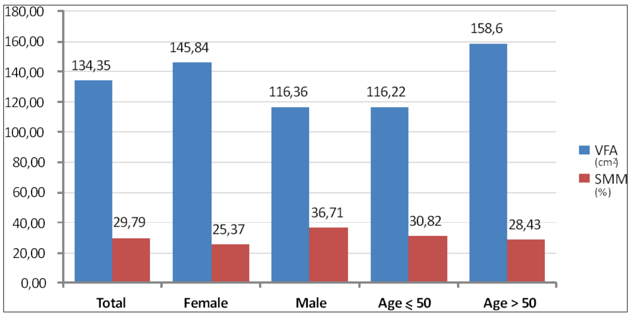

Figure 6. Comparison Chart of average values of VFA and SMM (n = 4,628).

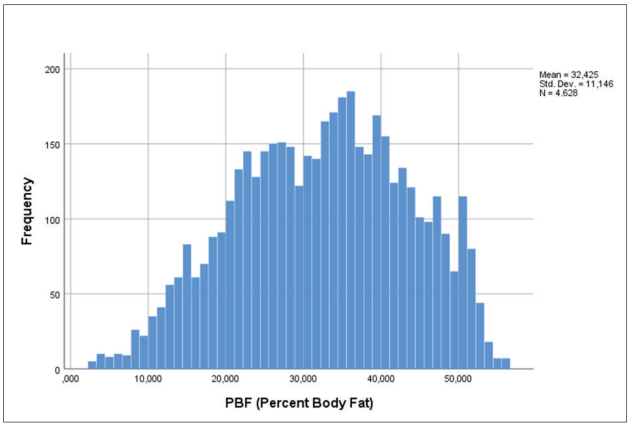

Figure 7. Histogram of the Percent Body Fat (PBF) (n = 4,628).

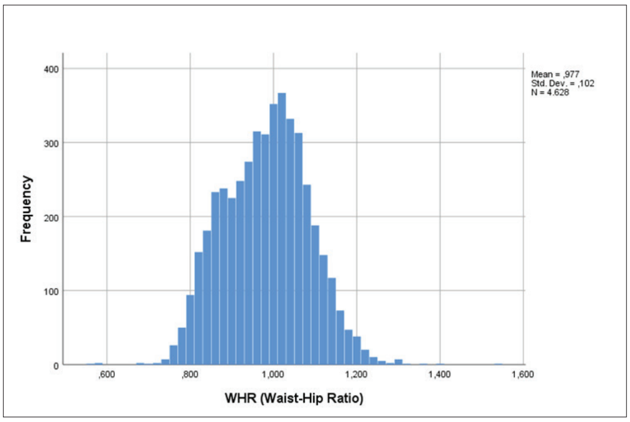

Figure 8. Histogram of the Waist-Hip Ratio (WHP) (n = 4,628).

parameters were used: BMI, BFM, FFM, PBF, WHR and their relationship. PBF and WHR have significantly greater diagnostic value in assessing the type of obesity than the use of only one parameter such as BMI.

The histograms of key anthropometric parameters are shown in the Figures 1 – 5. None of the paramters was normally distributed.

BMI is a non-specific parameter and cannot determine the type of obesity or risk factors for the development of metabolic syndrome.

The total amount of obesity compared to the total weight of skeletal fat tissue may indicate the possibility of insulin resistance and the development of metabolic syndrome in cases where the values of total fat and low values of skeletal muscle mass (SMM) are high (Figure 2).

Table 2 and Figure 5 show that over 50% of subjects have a significantly increased amount of visceral fat, and that this amount progressively increases with age.

The tables show changes in the amount of SMM and total adipose tissue (BFM). Reduced amounts of skeletal muscle mass and increased values of total adipose tissue accompany the aging process, so this relationship is significantly disrupted in older age. Even more significant changes are expressed in the analysis of visceral adipose tissue. The above parameters may be important factors for assessing the presence of IR and the development of metabolic syndrome and MASLD.

Assessment of the type and distribution of adipose tissue, such as the amount of visceral adipose tissue in cm2 additionally enables a better analysis of the degree and type of obesity (Table 2, Histogram 5).'

Figure 3 shows the ratio of total BFM to BMI in percentage (PBF). An increased percentage of total fat tissue PBF also indicates a pathological distribution of subcutaneous, abdominal or visceral fat tissue.

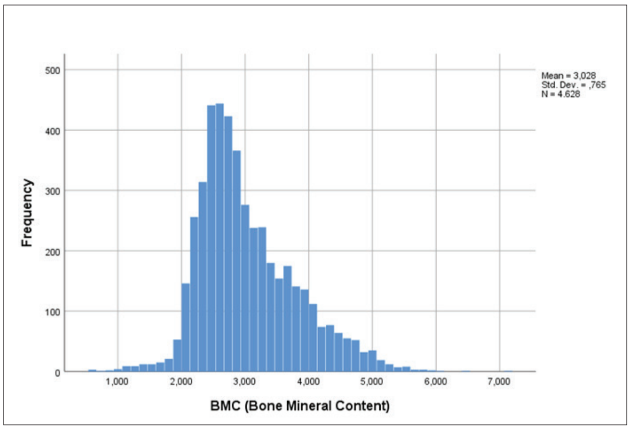

Figure 9. Histogram of the Bone Mineral Content (BMC) (n = 4,628).

Figure 8 shows the relationship between waist and hip circumference. The increased values demonstrated in our subjects indicate an abdominal type of obesity, which is an important parameter in the diagnosis of IR.

Bone mineral content is suboptimal in almost half of the examined subjects, pointing to high risk of progression to osteoporosis in their advanced age. The average mineral content in the subjects is below normal values, which indicates the possibility of frequent musculoskeletal diseases. In combination with SMM (skeletal Muscle Mass), FFM and total weight, it can also show differences in the distribution of fat tissue.

5. DISCUSSION

All epidemiological data during the 21st century indicate that a significant upward trend in the prevalence of obesity in both sexes and all ages continues despite the implementation of proposed measures for nutrition, physical activity, and lifestyle modification (1,2).

Obesity prevalence with simple anthropometric measurement of body mass index (BMI), extensive WHO lifestyle modification programs, various dietary programs, medication and bariatric surgery have not led to the expected results, so there is a need to redefine the general approach to this most significant health problem of the entire population (5). New studies on the etiopathogenesis of this disease indicates that there are various etiological factors that require specific diagnostic and therapeutic measures (5, 6, 8, 9).

The clinical presentation of obesity has a wide spectrum, from examples of metabolically „healthy obesity“ to the occurrence of severe forms of metabolic syndrome, or chronic non-communicable diseases that significantly reduce the quality and length of life. A global consensus has been reached in the health system that a new definition and classification of obesity is needed.

The new EB definition differentiates the appearance of obesity according to disorders of specific organs that directly affect appetite intake and energy consumption of food (5). Disorders in the brain, oral cavity, stomach and intestines (GUT), visceral adipose tissue (Mesentery) and liver give different types of obesity that require different diagnostic and therapeutic approaches (5, 7, 10, 13). According to clinical manifestations, obesity can be divided into clinical and preclinical. Clinical obesity is a chronic, systemic disease with the development of insulin resistance and all the consequent diseases that include metabolic syndrome and MASLD (5, 6).

To assess which type of obesity a patient belongs to, it is also necessary to change the diagnostic criteria. Anthropometric measurement with BMI does not meet the new criteria, so there is a need to apply more

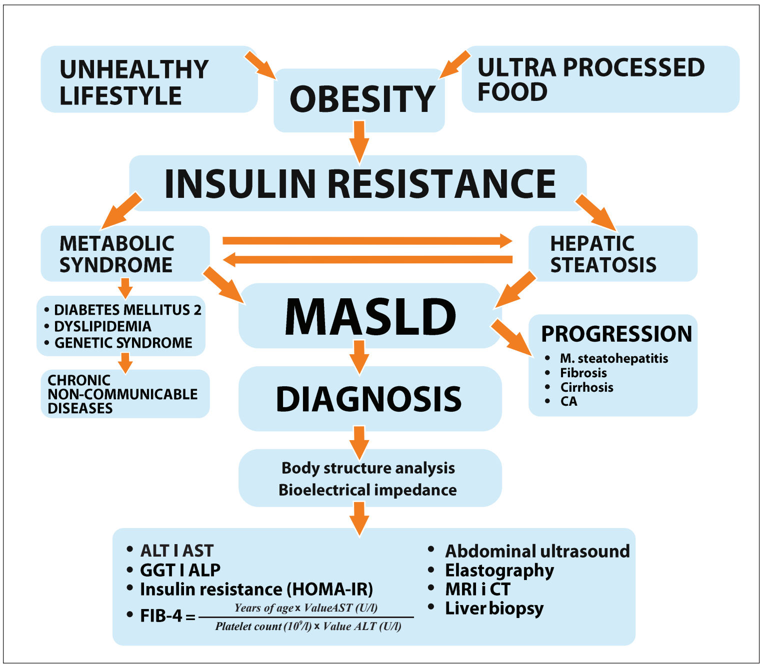

Figure 10. Algorithm of diagnostic procedures in the diagnosis of the type of obesity

parameters that would indicate risk factors for the development of metabolic syndrome (6, 8, 13).

In family medicine practice, the following algorithm can be used in the treatment of obese patients. After obtaining anamnestic data on lifestyle and nutrition, the analysis of the patient's body structure helps to perform additional clinical examinations that will determine the type of obesity and the metabolic changes present with an assessment of the liver condition. Only on the basis of the final diagnosis can all preventive and therapeutic procedures be included (Figure 10).

Most of the tissue structure parameters measured with bioelectrical impedance are related to the amount and distribution of visceral fat. The amount and distribution of visceral fat can be assessed with imaging methods such as CT, MRI, dual-energy X-ray absorption, ultrasound, and bioelectrical impedance. The simplest method for widespread use is bioelectrical impedance. This method, which measures bioelectrical conductivity across different tissues, is noninvasive, easy to perform, radiation-free, and can be repeated multiple times to assess the effects of the applied therapy (9, 13, 17-19).

In our study of 4628 family medicine patients, body composition was analyzed in relation to the amount and distribution of adipose tissue. Due to the important interrelationship with skeletal muscle tissue, an additional analysis of the total mass of this tissue was performed. Since there is a clear connection between visceral adipose tissue and insulin resistance, muscle tissue, as an important factor in the pathogenesis of IR, may be an additional parameter in the new classification of obesity. Other diseases such as tumors, sarcopenia, and osteoporosis may also have an impact on the clinical manifestations of obesity itself (18).

Our results indicate that there are significant differences in the ratios of skeletal muscle and visceral fat tissue in relation to gender and age. With age, the amount of muscle mass decreases and the mass of visceral tissue increases, which certainly affects the faster development of IR. Elevated values of the WHP ratio are accompanied by increased amounts of visceral fat tissue, so it can be concluded that both parameters may be a significant factor in distinguishing clinical and preclinical obesity (5, 14-17).

The results of our study, as well as the results of other authors, confirm that it is justified to apply bioelectrical impedance analysis in the practice of family medicine. Such analysis allows us to obtain results in a simple way, without the need for other expensive diagnostic procedures (MRI, CT scan), which allow us to classify obesity and apply appropriate treatment (13, 17).

In addition to clinical data on the development of metabolic syndrome or MASLD according to the proposed algorithm, it is necessary to apply specific dietary, drug and bariatric interventions (13-17, 21, 22). The interrelationship between insulin resistance and the amount of visceral adipose tissue can be explained etiopathogenically by the portal theory. Products of adipose tissue of mesenteric origin, including adipokines and free fatty acids, enter the systemic circulation via the portal circulation and the liver. Severe hepatic steatosis itself may be an additional important parameter for the diagnosis of clinical obesity.

Anthropometric analysis provides important information about nutritional status, but also about the amount and distribution of adipose tissue, as well as the risk for a large number of comorbid conditions, which is why new research is needed for a certain range of anthropometric parameters with proven sensitivity and specificity for clinical practice and population studies (17, 21, 22).

6. CONCLUSION

Our study shows that more than a quarter of Bosnia and Herzegovina population is obese, with abdominal obesity type, which carries the highest risk of insulin resistance, metabolic syndrome and MASLD.

Respondents came to their family doctor due to clinical signs of obesity-related comorbidities, without being aware of the underlying disease. Determination of anthropometric parameters by bioelectrical impedance related to body structures such as: BMI, BFM, PBF, SMM, visceral fat area and minerals allows to classify obesity into clinical or preclinical form at the first examination. Our results indicate that the majority of respondents have significantly higher amounts of visceral fat and high values of waist-hip ratio, which correlates with the existence of IR. IR has a proven link to the development of MASLD and metabolic syndrome. Such results require additional clinical trials and specific measures that, in addition to lifestyle modification, also include other therapeutic procedures such as modern drug therapy and bariatric surgery. Control of anthropometric parameters by bioelectrical impedance can also be an important factor for assessing the effectiveness of therapeutic strategies. Parameters of distribution and amount of visceral fat tissue determined by the bioelectrical impedance method can be useful in the classification of obesity and the selection of strategies for the prevention and treatment of various forms of obesity.

Bone mineral content and SMM are suboptimal in almost half of the examined subjects, pointing to high risk of progression to osteoporosis and sarcopenia in their advanced age. Further elucidation and research of the function visceral adipose tissue can lead to better understanding etiopathogenesis of development clinical obesity, Urgent public health actions are needed to decrease obesity and improve nutrition of the population in order to prevent increase of burden of metabolic syndrome and MASLD. Screening for obesity including anthropometric parameters by use bioelectrical impedance should be performed on all adult patients in family medicine practice once a year.

- **Author's conribution:** The all authors were involved in all steps of preparation this article. Final proofreading was made by the first author.
- **Conflict of interest:** None to declare.
- **Financial support and sponsorship:** Nil.

REFERENCES

1. World Health Organization. WHO European Regional Obesity Report 2022. WHO Regional Office for Europe; Copenhagen, Denmark: 2022.
2. CD Risk Factor Collaboration (NCD-RisC). Worldwide trends in underweight and obesity from 1990 to 2022: a pooled analysis of 3663 population-representative tudies with 222 million children, adolescents, and adults. Lancet. 2024; 403(10431): 1027-1050. doi: 10.1016/S0140-6736(23)02750-2
3. Salihefendic N Zildžic Obesity and Pediatric Fatty Liver: The Silent Epidemic and Significant Health Problem. Psychiatria Danubina, 2020; 32(Suppl. 3: 378-381.
4. Unamuno X, Ambrosi1 JG, Rodríguez A, et al. Adipokine dysregulation and adipose tissue inflammation in human obesity. Eur J Clin Invest. 2018; 48: e12997. doi: 10.1111/eci.12997.

5. Francesco R, et al. Definition and diagnostic criteria of clinical obesity. Lancet Diabetes Endocrinol. 2025. doi: 10.1016/S2213-8587(24)00316-4.
6. Jung UJ, Choi MS. Obesity and its metabolic complications: the role of adipokines and the relationship between obesity, inflammation, insulin resistance, dyslipidemia, and nonalcoholic fatty liver disease. Int J Mol Sci. 2014; 15(4): 6184-6223. doi: 10.3390/ijms15046184.
7. Salihefendić N, et al. The importance of regulation of the digestive system–brain interactions on prevention of insulin resistance and fatty liver. Hrana u zdravlju i bolesti, Specijalno izdanje (10. Štamparovi dani). 2018; 118-122. Available from: https://hrcak.srce.hr/218638.
8. Witczak-Sawczuk K, Ostrowska L, Cwalina U, et al. Estimation of the impact of abdominal adipose tissue (subcutaneous and visceral) on the occurrence of carbohydrate and lipid metabolism disorders in patients with obesity - A pilot study. Nutrients. 2024; 16(9): 1301. doi:10.3390/nu16091301.
9. Salihefendic D, Zildzic M, Masic I. The importance of the quantity and the distribution assessment of fat tissue in a diagnosis of insulin resistance. Med Arch. 2020; 74(6): 439-443. doi: 10.5455/medarh.2020.74.439-446.
10. Zildžić M, et al. Uloga mezenterija, kao novog organa, u procesu digestije. Hranom do zdravlja. 2017; 10(1): 2232-2953.
11. Oka R, Yagi K, Sakurai M, et al. Impact of visceral adipose tissue and subcutaneous adipose tissue on insulin resistance in middle-aged Japanese. J Atheroscler Thromb. 2012; 19(9): 814-822. doi: 10.5551/jat.12294.
12. Bertoli S, Leone A, Vignati L, et al. Metabolic correlates of subcutaneous and visceral abdominal fat measured by ultrasonography: a comparison with waist circumference. Nutr J. 2016; 15: 2. doi: 10.1186/s12937-015-0120-2.
13. Coffey JC, O'Leary DP. The mesentery: structure, function, and role in disease. Lancet Gastroenterol Hepatol. 2016; 1(3): 238-247. doi:10.1016/S2468-1253(16)30026-7.
14. Yang YK, Chen M, Clements RH, et al. Human mesenteric adipose tissue plays unique role versus subcutaneous and omental fat in obesity-related diabetes. Cell Physiol Biochem. 2008; 22(5-6): 531-538. doi: 10.1159/000185527.
15. Rahiman S, El-Metwally TH, Shrivastava D. Adipose tissue: a regulator for obesity and its complications. Int J Biochem Res Rev. 2015; 9(1): 1-9. doi: 10.9734/IJBCRR/2016/18221.
16. Kwon H, Kim D, Kim JS. Body fat distribution and the risk of incident metabolic syndrome: a longitudinal cohort study. Sci Rep. 2017; 7: 10955.
17. Lee DH, Park KS, Ahn S, et al. Comparison of abdominal visceral adipose tissue area measured by computed tomography with that estimated by bioelectrical impedance analysis method in Korean subjects. Nutrients. 2015; 7(12): 10513-10524. doi: 10.3390/nu7125548.
18. Gao B, Liu Y, Ding C, et al. Comparison of visceral fat area measured by CT and bioelectrical impedance analysis in Chinese patients with gastric cancer: a cross-sectional study. BMJ Open. 2020; 10(7): e036335. doi: 10.1136/bmjopen-2019-036335.
19. Pescatori LC, Savarino E, Mauri G, et al. Quantification of visceral adipose tissue by computed tomography and magnetic resonance imaging: reproducibility and accuracy. Radiol Bras. 2019; 52(1): 1-6. doi:10.1590/0100-3984.2017.0211.
20. Frayn KN. Visceral fat and insulin resistance - causative or correlative. Br J Nutr. 2020; 83(1): 71-77. doi:10.1017/S0007114500000982.
21. Zildzić M, Salihefendić N, Masić I. The mesentery's pivotal role in the brain-gut-liver axis. Med Arch. 2024; 78(1): 4-8.
22. Walczyk T. Anthropometric indicators of obesity: Are the new indicators a better predictor of body fat content than BMI? J Educ Health Sport. 2021; 11: 11-23.