I. SUMMARY

Obesity is a chronic disease, with its characteristic feature consisting in excessive body fat. It increases the risk of developing chronic diseases, such as: cardiovascular diseases, carbohydrate metabolism disorders, cancer, and joint diseases (resulting to a large extent from putting an extensive load on them). Taking into consideration the type and distribution of white adipose tissue, we distinguish *subcutaneous abdominal tissue* (SAT) and *visceral abdominal tissue* (VAT). Both tissues also differ in the role they play in the body.

The aim of the research was to assess the impact of the distribution of abdominal fat (subcutaneous SAT and visceral VAT estimated at the height of the navel) on selected metabolic parameters and on specific parameters of cardiopulmonary fitness in terms of people with obesity.

The research included 91 obese people (59 women and 32 men) who met the criteria for being included in the study and who did not possess exclusion criteria. In the years 2016– 2020, the consent of the Bioethics Committee of the Medical University of Bialystok No. R-I-002/442/2015 and No. R-I-002/591/2019 was obtained. All study participants were characterized by abnormal waist circumference (women ≥ 80 cm, men ≥ 94 cm). The criterion for dividing them into research groups consisted in determining metabolic disorders or their absence: the G1 group consisted in people of both sexes with obesity, in whom no additional components of the metabolic syndrome were found; the G2 group consisted of people of both sexes with obesity, in whom only one additional component of the metabolic syndrome was found (e.g. triglycerides ≥ 150 mg/dl, HDL cholesterol in women < 50 mg/dl, and in men < 40 mg/dl, or glycaemia ≥ 100 mg/dl), but it was not a disease previously diagnosed and treated; Group G3 consisted of people of both sexes who met the full criteria for diagnosing the metabolic syndrome. Individual groups were divided according to gender.

The research was carried out in 3 stages. Stage 1 was carried out at the Department of Dietetics and Clinical Nutrition of the UMB. During the visit, the subjects were provided with detailed information concerning the research and every participant signed a voluntary consent to participate in the research. Furthermore, an interview questionnaire concerning the duration of obesity and past diseases was collected, and an assessment of the status of nutrition based on anthropometric measurements was carried out, and a body composition

analysis was performed using the bioelectroimpedance method using the Maltron BioScan 920-2 analyzer. Then, patients were issued a referral for laboratory examinations. Stage 2 was carried out at the Medical Laboratory at the University Clinical Hospital in Bialystok, where blood was taken from the ulnar vein (in the amount of 15ml). The concentrations of the following parameters were determined from the blood serum: fasting glucose, fasting insulin, total cholesterol, LDL cholesterol fraction, HDL cholesterol fraction, triglycerides, C-reactive protein (CRP), uric acid, creatinine, and aminotrasferases: alanine (ALT) and aspartate (AST). On the basis of fasting glucose and fasting insulin, the HOMA – IR insulin resistance index was calculated. Stage 3 was carried out at the Maniac Gym Fitness Club in Bialystok, where cardiopulmonary fitness was assessed using the Modified Bruce protocol.

All obtained results were subjected to statistical analysis using the following statistical software: STATISTICA 13.3 (Stat Soft) and R version 4.1.1 (The R Foundation for Statistical Computing, Vienna, Austria). The normality of the distribution of quantitative variables was verified using the Shapiro-Wilk test. In this work, the following tests have been used: U Mann–Whitney, Kruskal–Wallis, independence chi – Pearson square, and Spearman correlation coefficient. An attempt was also made to estimate the cut-off points for VAT, SAT, and VAT/SAT ratio in relation to increasing metabolic parameters (in the case of decreasing HDL cholesterol fraction), for this purpose the Mann–Whitney–Wilcoxon U test was used. The final stage of statistical analyses consisted in creating 3 linear regression models for women using the step forward method for the estimated VAT, SAT at the navel, and VAT/SAT ratio, as well as the researched metabolic parameters and cardiopulmonary fitness. The insufficient size of the analyzed group of men constituted a factor preventing creating such regression models for them. The F Fisher test was used to research the significance of multiple regression. In all the results obtained in this work, those where $p < 0.05$ were considered statistically significant.

The women of the G1a, G2a, and G3a researched groups did not differ statistically significantly in terms of assessed anthropometric parameters (BMI, waist circumference, WHR, WHtR, and RFM). Whereas, the men showed significant differences in terms of average waist circumference, waist-height ratio, and relative body fat content. Analyzing the differences concerning body composition of the researched women, it was shown that patients with "uncomplicated" G1a obesity were characterized by a significantly lower percentage of body fat than patients with obesity and G3a metabolic syndrome. Whereas, the men differed significantly in terms of body fat concerning all three researched groups.

The researched women and men differed in the average values of the visceral abdominal tissue estimated at the height of the navel (VAT), the subcutaneous abdominal tissue estimated at the height of the navel (SAT), and the VAT/SAT ratio. In own work, positive correlations were shown in terms of women between the percentage of body fat and fasting glucose, fasting insulin concentration, HOMA – IR index, serum triglyceride concentration, and C reactive protein. In turn, in terms of men, positive correlations between body fat percentages concerned only CRP concentration.

In women, BMI correlated positively with the concentration of C reactive protein, and in men a positive correlation was observed between BMI and fasting insulin concentration and C reactive protein concentration. The waist circumference correlated positively in women with fasting glucose and C reactive protein C, and in men with fasting insulin and CRP. Both in terms of women and men, a positive correlation was observed between RFM and the concentration of C reactive protein. In the researched women, positive correlations were observed between the field of visceral abdominal tissue (VAT) estimated at the height of the navel and the concentration of triglycerides, fasting glucose, serum uric acid, HOMA – IR, and CRP concentration, while in men with fasting insulin and AspaT concentration. The subcutaneous abdominal tissue (SAT) estimated at the height of the navel in women correlates positively with the concentration of CRP, the value of the HOMA – IR index, the concentration of fasting glucose, the concentration of fasting insulin, and the concentration of LDL cholesterol fraction, and in men positively with the concentration of fasting insulin and CRP, while there were negative correlations with the concentration of HDL cholesterol fraction. Only in the researched group of women, the VAT/SAT ratio correlated positively with the concentration of TG, and negatively with the concentration of HDL cholesterol. An attempt was made in the own research to estimate cut-off points for the VAT field, at which increased values of the analyzed metabolic parameters were observed and in the group of women they were determined for the increasing fasting glucose concentration (239.56 cm^2), the increasing HOMA – IR index (212.43 cm^2 – was close to the average VAT value in the group of patients with obesity and one additional metabolic disorder), decreasing HDL cholesterol (245.40 cm2), and increasing TG concentration (238.27 cm^2). Whereas, in men, VAT cut-off points were estimated for the increasing HOMA – IR index (267.96 cm^2 – also close to the average VAT value in the group of patients with obesity and one additional metabolic disorder), and increasing triglyceride concentration (284.65 cm^2). In women, cut-off points of the SAT field assessed at navel level were

estimated for increasing fasting glucose (123.26 cm^2), fasting insulin (122.39 cm^2), increasing HOMA – IR (124.64 cm^2), increasing serum uric acid (127.43 cm^2), and decreasing HDL cholesterol (124.78 $cm^{2)}$), while for men it was not possible to estimate SAT cut-off points for any of the assessed parameters. VAT/SAT ratio cut-off points were also estimated in terms of women for increasing fasting glucose (1.99), decreasing HDL cholesterol (2.03), and increasing TG (2.08), and in men for increasing fasting insulin concentration (2.04), increasing HOMA – IR (2.21), and for increasing TG concentration (2.31).

In assessing the cardiopulmonary fitness, it was observed that the women of the researched groups differed significantly in terms of minute ventilation and the duration of the test, no differences were observed in terms of men. The peak heart rate during the test correlated negatively with the percentage of body fat, waist circumference, and RFM only in women. The VAT estimated at the height of the navel correlated positively with peak VO_2, peak HR, overall body performance, exercise capacity, and negatively with minute ventilation in women. The SAT field estimated at the height of the navel in terms of women correlated positively with peak VO_2, overall body performance, exercise capacity, and anaerobic threshold, and in terms of men it correlated positively with minute ventilation. Whereas, the VAT/SAT ratio in terms of women correlated negatively with peak VO_2, peak HR, overall body performance, exercise capacity, and anaerobic threshold, and positively with minute ventilation, while in terms of men it correlated only negatively with minute ventilation.

In the constructed regression model concerning women, it was found that the VAT field estimated at the height of the navel was statistically significantly related to triglyceride concentration, minute ventilation, and peak HR. While, such a model created for SAT took into account significant associations with the concentration of C reactive protein, anaerobic threshold, fasting insulin concentration, and LDL cholesterol concentration. The final regression model was the VAT/SAT ratio model, in which the relation between the VAT field and the SAT field at the height of the navel was statistically significantly related to: serum triglycerides concentration, minute ventilation, overall body performance, peak HR, serum creatinine and alanine aminotransferase concentration.

On the basis of the obtained research results, it seems that in order to assess the impact of the distribution of subcutaneous abdominal tissue (SAT) and visceral abdominal tissue (VAT) on the occurrence of metabolic disorders and cardiopulmonary fitness parameters,

it would be reasonable to assess the total content of these tissues with the use of the DXA or CT methods.