

Professional paper

OBESITY

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Kristina Vukušić¹

College of Sports and Health, Belgrade, Serbia

Desanka Filipović

College of Sports and Health, Belgrade, Serbia

Snežana Milićev

College of Sports and Health, Belgrade, Serbia

Abstract: Obesity is a chronic disease characterized by an increase in body fat mass, to the extent that leads to compromised health and the development of a series of complications. In the assessment of obesity anthropometry is commonly used. Obesity is defined by body mass index ≥ 30 kg/ m². Obesity leads to increased morbidity and mortality of the diseases associated with obesity, such as cardiovascular diseases, type 2 diabetes, reproductive disorders and some types of malignancies. In assessing the risk of developing obesity complications, besides the total weight of body fat, it is also important to take into account regional body fat distribution. Abdominal obesity, and especially higher inter-abdominal visceral adiposity, is closely related to the most significant obesity complications (metabolic, cardiovascular and malign diseases). Obesity is a disease which can be treated. Treatment strategy involves a special diet, scheduled physical activity, medication and surgical treatment.

Keywords: *obesity, visceral adiposity, obesity complications, anthropometry*

INTRODUCTION

Obesity is one of the most serious health challenges of the 21st century. According to the World Health Organization data, more than 600 million adults worldwide are obese. Given the existence of the obesity

¹ ✉ kristinavukusic@vss.edu.rs

complications and an increased rate of morbidity and mortality in obese people, the disease has a major medical and socio-economic significance (Branca et al., 2007).

1. DEFINITION AND CLASSIFICATION OF OBESITY

According to the definition of the World Health Organization (WHO), obesity is a chronic disease characterized by increasing body fat accumulation, to the extent which leads to compromised health and the development of a series of complications (Branca et al., 2007). Recommendation of the WHO for the classification of underweight, overweight and obesity in adults is to use Body Mass Index - BMI. Excess body weight is defined as $BMI \geq 25 \text{ kg/m}^2$. Pre-obesity is the condition of having a BMI from 25 to 29.9 kg/m^2 . Obesity is defined by $BMI \geq 30 \text{ kg/m}^2$. First degree obesity is BMI from 30 to 34.9 kg/m^2 , second degree obesity is BMI from 35 to 39.9 kg/m^2 and third degree obesity is $BMI \geq 40 \text{ kg/m}^2$ (Branca et al., 2007).

Abdominal obesity implies accumulation of body fat distributed around abdomen, which can be measured by waist circumference ($WC \geq 94 \text{ cm}$ for men and $\geq 80 \text{ cm}$ for women), as well as by the waist-to-hip ratio ($WHR \geq 0,90$ for men and $\geq 0,85$ for women) (Wajchenberg, 2000).

With the development of contemporary visualization methods for detection and measurement of body fat, which enable the measurement of subcutaneous and visceral body fat, in today's literature new terminology is generally used for the obesity types, which makes a distinction between visceral and subcutaneous obesity. Visceral obesity involves accumulation of body fat within the body cavities and it is defined by the surface of visceral abdominal body fat and/ or the proportion of surfaces of visceral and subcutaneous abdominal body fat, an important index which indicates the distribution of abdominal body fat ($VFA > 100 \text{ cm}^2$ and $VFA/SFA \geq 0.4$ measured by computerized tomography) (Wajchenberg, 2000).

2. PREVALENCE OF OBESITY

Overweight and obesity represent one of the most serious public health challenges of the 21st century. The prevalence of obesity around the world doubled between 1980 and 2014. According to the data by the WHO from 2014 more than 1.9 billion of world adults are overweight, whereby 600 million is obese (World Health Organisation - WHO, 2014); (10-60% of adult population, while obesity is more common amongst women 7.1 % - 35.6%) (Branca et al., 2007). The prevalence of obesity is especially high in

developed countries. Obesity trend is alarming in children, adolescents and at fertile age. Even though it is more common to find incidence of underweight in geriatric population, more and more obesity occurs in people older than 65 years (Branca et al., 2007). As per the published findings of the health research for the population of Serbia in 2006, the data about our country are as follows:

- Over one half of adult population (54.5 %) has an overweight issue (pre-obesity and obesity), whereby 18.3 % of adults are obese.
- There are no significant differences in obesity between men and women. Obesity percentage increases with age, whereby from 75 and more years there is a significant decrease in the percentage of obese (Milosavljević, Grozdanov, 2007). National data on the prevalence of abdominal and visceral obesity are mostly insufficient (Branca et al., 2007).

3. ETIOPATHOGENESES

Etiopathogenesis is multifactorial. Pathophysiology of obesity may seem as simple, chronic overload of nutrients, which overcomes the level of energy consumption. However, due to the complexity of neuroendocrine and metabolic systems which control the intake, deposit and energy consumption, it is difficult to establish all the important parameters which influence the development of obesity. The main reason for the increase in the number of obese people is the way of living without physical activity and high calorie intake diet. More and more attention is paid to the study of genetic syndromes and other specific syndromes related to obesity (Cushing's syndrome, hypothyreosis, insulinoma, hypothalamus disorders), which will contribute to the understanding of the different types of obesity (Flier, 2004).

4. OBESITY COMPLICATIONS

Obesity has numerous health consequences, it leads to a significant increase in morbidity and mortality (Figure 1). Extremely obese people have doubled the mortality rate (Flier, 2004). Abdominal obesity, and especially higher intra-abdominal visceral adiposity, is closely linked to the most important metabolic and cardiovascular obesity complications. It is assumed that the link comes from higher lipolytic activity of intra-abdominal visceral body fat, direct exposition of hepatocyte through portal circulation, increased concentration of free fatty acids and/ or other active substances (adipocytokines) from visceral body fat (Fox, 2007).

Figure 1. *Obesity complications*
(Source: Micić, 2004, 3-4)

I Hormonal and metabolic complications

- Metabolic syndrome:
 - Diabetes mellitus type 2
 - Insulin resistance
 - Dyslipoproteinemia
 - Hypertension
- Disorders of hormone and circulating factors levels: Cytokines; Ghrelin; Growth hormone; Hypothalamic–pituitary–adrenal axis; Leptin; The renin–angiotensin system

II Diseases of the organic systems

- Diseases of the cardiovascular system
 - Cerebral Vascular malformations
 - Congestive heart failure
 - Cardiac ischemia
 - Arterial hypertension
 - Thromboembolic disorders
- Diseases of the respiratory system
 - Obesity hypoventilation syndrome
 - Sleep apnea syndrome
- Diseases of the gastrointestinal tract
 - Cholelithiasis
 - Fatty infiltration of the liver
- Abnormalities of the reproductive system
 - Hormonal complications in men and women
 - Obstetrical complications
- Nervous system
- Immune systems dysfunctions
- Skin diseases

III Malignancies

- Breasts
- Colon
- Female reproductive organs: endometrium, ovary
- Gallbladder
- Kidney; Prostate

IV Mechanical complications

- Arthrosis
- Lumbar syndrome

V Surgical complications

- Perioperative risk: anesthesiology complications
- Wound complications; incisional hernia

VI Psycho-social complications

4.1. Hormonal and metabolic complications

Metabolic syndrome

Metabolic syndrome (MetSy) is the name for a group of risk factors which predispose the occurrence of diabetes type 2 and cardiovascular diseases. According to the latest diagnostic criteria, metabolic syndrome exists if any of three out of five risk factors are present: abdominal obesity, high level of triglycerids, lower level of HDL cholesterol, high blood pressure and elevated fasting glucose (Alberti et al., 2009; Beljić Živković, 2012).

Insulin resistance, hyperinsulinemia and diabetes type 2

Insulin resistance is defined as a metabolic disorder in achieving insulin effects through insulin receptor, when higher concentration of insulin is required in order to obtain normal biological response of skeletal muscles, liver and fat tissue to insulin. The causes of developing insulin resistance in obesity can be multiple: disorders in synthesis and secretion of insulin, the existence of antibodies to insulin or insulin receptors, the effect of antagonistic hormones (glucagon, glucocorticoids, growth hormones) and defects at the level of target organs and tissues (decrease in the number and affinity of insulin receptors). Insulin resistance influences the development of MetSy through increased level of free fatty acids and abnormal adipokines profile. Hyperinsulinemia provides normoglycemia within a limited time period, and when β pancreatic cells are exhausted hyperglycemia occurs (Le Roith & Cohen, 2012). In the pathogenesis of diabetes type 2, the key role of insulin resistance is prominent in peripheral tissues and liver. Higher concentration of free fatty acids and glucose lead to apoptosis of β pancreatic cells, decreased insulin secretion and the development of diabetes (Beljić Živković, 2012).

4.2. Dyslipoproteinemia

Combination of hypertriglyceridemia, lowered levels of HDL cholesterol and increased concentration of small dense particles of LDL cholesterol (A to B) is a typical atherogenic dyslipidemia which occurs in abdominal obesity, especially in accumulated body fat and in diabetes. The pathophysiology of lipids metabolism in obesity is explained by changed activity of lipoprotein lipase enzymes in fat tissue and hepatic lipase (Despres, 2006).

4.3. Diseases of the cardiovascular system

The pathogenesis of hypertension caused by obesity includes significantly disrupted functions of the renin–angiotensin system and hyperinsulinemia, which as a consequence lead to increased retention of salts, accumulation of sodium and

calcium in smooth muscle cells, hypertrophy of the vessel wall, vasoconstriction and increased cardiac output. Obesity is followed by endothelium dysfunction and atherogenic lipides profile, which also contributes to the development of atherosclerosis and hypertension (Visscher & Seidell, 2001). Framingham study has showed that obesity is an independent risk factor for the incidence of cardiovascular diseases (CVD), including the development of myocard infarct, congestive heart failure, atherothrombotic insults and the occurrence of sudden death, and it is estimated that the reduction of body weight by 20 % would reduce the risk of coronary event by 40 % (Frühbeck, 2004). In risk assessment of CVD an important factor is the regional distribution of obesity. Abdominal obesity, especially section of visceral body fat (VAT), corresponds much stronger with cardiovascular risk of general obesity and subcutaneous body fat. Anthropometric measurements point out moderate to high correlation between obesity and CVD risk factors and they are important predictors of increased cardiometabolic risk (Barreira et al., 2012). Waist circumference and the waist-to-hip ratio are most commonly used anthropometric parameters for the estimate of abdominal obesity. The advantage and economy of these methods have led to their inclusion into several guidelines for the establishment of cardiovascular risk, especially pertaining to metabolic syndrome (Berker et al., 2010). Many researches revealed the significance of specific metabolic activity of visceral body fat, as an independent risk factor in the development of CVD (Demerath, 2008). It has been disclosed that people with the surface of visceral abdominal body fat (VFA) > 100 cm², measured by computerized tomography, have higher degrees of coronary artery disease (Berker et al., 2010). Accumulation of epicardial visceral body fat in thoracal region represents a risk factor for cardiovascular diseases, even in normal weight people (Rosito et al., 2008).

4.4. Diseases of the respiratory system

Lighter or moderate degree obesity does not necessarily cause more severe disorders of respiratory function, while they generally develop in extremely obese cases. All obesity complications of the respiratory tract can be classified into four groups: 1. Respiratory function disorders without alveolus hyperventilation, 2. Pickwickian syndrome, 3. Obstructive sleep apnea syndrome and 4. Risk during and after surgical interventions (Lepšanović i Ivković, 2001).

4.5. Diseases of the gastrointestinal system and liver diseases

Obesity can be related to reflux oesophagitis and hiatal hernia, due to increased mechanical burden of body fat onto abdominal organs. Obesity is a risk factor for esophagus cancer, gastric cardia and colon. It is also brought

into connection with acute pancreatitis, Chron's disease and functional disorders of intestines. As possible connection mechanisms insulin resistance and inflammatory role of body fat in obesity are pointed out, especially of intra-abdominal body fat (John et al., 2006). Cholelithiasis is very common pathology in the group of obese people, especially with abdominal obesity, due to increased hepatic secretion of cholesterol, decreased concentration of HDL and insulin resistance (Tsai et al., 2006). Nonalcoholic fatty liver disease implies deposition of fat in the liver and disorder of its function. It includes a wide clinical and pathological spectre: hepatomegaly, increased biochemical parameters of disordered liver function and changed histological structure of the liver. Fatty liver is detected by ultrasound, CR or MRI check ups for people with normal BMI, but it is also not found in all obese people, which is explained by stronger correlation with abdominal visceral obesity (Jang et al., 2011).

4.6. Malignancies

Numerous epidemiological studies have shown the relationship between obesity and malign tumors. Obese men are more likely to get colon, rectum or prostate cancer, while obese women are more likely to get endometrium cancer, breast and gallbladder cancer. High BMI is associated with increased incidence of many types of malignancies (~1,5 times higher risk with an increase of BMI of 5 kg/ m²) (Donohoe et al., 2011). Visceral obesity is even stronger predictor of cancer risk than BMI (Donohoe et al., 2011). Pathophysiological mechanisms which link obesity to tumorigenesis include paracrine and systematic effects. Paracrine mechanisms imply the production of proinflammatory cytokines, adipokines, growth factor and hypoxic environment. Systematic changes in obese people include chronic inflammation and changes in synthesis and secretion of adipokines and reproductive hormones. Insulin and growth factor similar to insulin (IGF) also have a complex and important role in tumorigenesis (Donohoe et al., 2011). Higher risk for the endometrium and breast cancer development is associated with increased level of estrogen, whose active form emerges from body fat stroma and with higher conversion of androgynous precursors into estradiol (Donohoe et al., 2011). It has also been noted that visceral body fat can influence the outcome of treatment for people with malign diseases, while angiogenesis factors produced by visceral body fat may influence tumor progression and response to chemotherapy (Donohoe et al., 2011).

4.7. Diseases of the locomotor system and skin

Obesity is linked to bone and muscles disorders, such as osteoarthritis of joints, hip and knee and discus hernia (Flier, 2004). Obesity causes a disorder of thermoregulation and hyperhidrosis, which makes a foundation

for the development of intertriginous skin changes and increases the risk from mycotic infections. Acanthosis may be present, which reflects the insulin resistance state and is manifested with darkening and thickening of skin at skin folds (Flier, 2004).

4.8. Reproductive disorders

Obese people are more likely to suffer from reproductive disorders, such as hormonal imbalance and reduced spermatogenesis in men, as well as anovulation, amenorrhea, polycystic ovary syndrome and sterility in women. Obese pregnant women often experience gestosis, gestational diabetes, abnormalities of placenta, the fetus has significantly increased risk of anomalies at birth, the level of folate is low in serum and there is increased risk of neural tube defect (Branca et al., 2007).

5. OBESITY DIAGNOSTICS

Minimum medical examination of the obese includes a discussion with the patient, physical examination and certain laboratory analysis (glycemia, AST, ALT, gama-GT, cholesterol, triglyceride, HDL, LDL-cholesterol, atherosclerosis index, TSH, urine test) (Micić et al., 2004). Numerous anthropometric measurements and indices are recommended for the assessment of obesity in clinical practice, since they are simple, cheap and available compared to other procedures (bioelectrical impedance analysis, dual-energy X-ray absorptiometry, ultrasound, magnetic resonance imaging, computerized tomography). Basic anthropometric measurements include: body height, body weight, skinfold thickness, waist circumference, hip circumference, sagittal abdominal diameter, body mass index and the waist-to-hip ratio. However, anthropometric measurements cannot differentiate between subcutaneous and visceral body fat (WHO, 2008; Berker et al., 2010).

6. OBESITY TREATMENT

The treatment of obesity has the aim of reducing the excess body fat, of maintaining the achieved treatment effects and the prevention of repeated increase in body fat. At the same time, a therapy of the specific causes of obesity is required, of risk factors and comorbidities, with the end goal to improve the quality of life of the patient. Treatment may include: dieting program, scheduled physical activity, medication and surgical treatment. The key in obesity treatment is a diet based on the principles of healthy eating,

where total calories intake should be reduced by 500 - 1000 kcal from the required level. Physical activity should be part of the body weight regulation regime, because besides the effects on the body fat reduction, it also beneficially impacts glucose regulation, blood pressure, lipids profile and general health condition. Indications for medication treatment should be considered with patients who failed to achieve results during 3 to 6 months of using some other method (dieting or physical activity), actually who did not manage to achieve and/ or maintain 10 % of body weight loss. Surgical treatment is the method of choice for extreme obesity (100 % above the ideal body weight, BMI > 40 kg/m², i.e. BMI > 35 kg/m² with existing comorbidities), and it implies several different methods of reducing the size of stomach and bypasses at different levels of the gastrointestinal tract (Micić et al., 2004; Flier, 2004).

CONCLUSION

Obesity is a chronic disease which is characterized by increasing the body fat to an extent which leads to compromised health and the development of a series of complications. Obesity is defined by body mass index BMI \geq 30kg/m². Considering a high prevalence of diseases with the tendency of further increase in the number of affected patients, the existence of obesity complications, increased morbidity and mortality rates in obese people, medical and socio-economic significance of this disease is huge. In the assessment of health risks, it is not only important to consider the entire body fat mass, but also its regional distribution. Abdominal obesity, and especially higher intra-abdominal visceral adiposity, through increased secretion of adipocytokines and production of free fatty acids, is strongly associated with the most significant complications of obesity (metabolic, cardiovascular diseases and malignancies). Although body mass index is not a direct measure of the body fat quantity, the recommendation is to use it for the classification of the degree of underweight or overweight in adults. Waist circumference is the most practical anthropometric measurement for the assessment of abdominal obesity, but it does not allow differentiation of subcutaneous and visceral abdominal body fat.

Etiopathogenesis of obesity is multifactorial, but the main cause is sedentary lifestyle and unhealthy diet. Education is necessary about healthy living habits, as well as healthy diet as a mandatory means of prevention. Obesity is a disease which can be cured. Treatment strategy includes dietary regime, scheduled physical activity, medication and surgical treatment. Future research in this area should be guided towards the significance of visceral body fat and finding the simplest measurement method of intra-abdominal deposits of body fat.

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