MONITORING OF SELECTED ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS IN MEN AND WOMEN IN BARDEJOV DISTRICT

Janka Poráčová[1], Mária Konečná[1], Vincent Sedlák[1], Marta Mydlárová Blaščáková[1], Meryem Yildiz[1], Viktória Rybárová[1], Mária Zahatňanská[2], Tatiana Kimáková[3], Melinda Nagy[4], Mária Majherová[5], Ivan Uher[6]

[1]Department of Biology, Faculty of Humanities and Natural Sciences, University of Prešov, Prešov, Slovak Republic
[2]Institute of Pedagogy, Andragogy and Psychology, Faculty of Humanities and Natural Sciences, University of Prešov, Prešov, Slovak Republic
[3]Department of Public Health and Hygiene, Faculty of Medicine, Pavol Jozef Šafárik University in Košice, Košice, Slovak Republic
[4]Department of Biology, Faculty of Education, J. Selye University, Komárno, Slovak Republic
[5]Department of Physics, Mathematics and Technics, Faculty of Humanities and Natural Sciences, University of Prešov, Prešov, Slovak Republic
[6]Institute of Physical Education and Sports, Pavol Jozef Šafárik University in Košice, Košice, Slovak Republic

SUMMARY

Objectives: Metabolic and cardiovascular diseases represent a significant and ever-increasing problem, accounting for nearly one-third of all deaths and leading to significant morbidity. Lifestyle changes, which introduce new risk factors for cardiovascular disease, are leading to an increase in the risk of cardiovascular disease worldwide. The burden of cardiovascular disease can be reduced by careful risk reduction, and as such, primary prevention is an important priority for all. There is strong consensus among international guidelines regarding the necessity of smoking cessation, weight optimization, and the importance of exercise, while guidelines differ slightly in their approach to hypertension and vary greatly in their approach to the optimal lipid profile, which remains a controversial issue.

Methods: The work is focused on the analysis of biochemical (glucose, cholesterol and triacylglycerols) and anthropometric (body mass index) parameters in selected probands (n = 140), including men (n = 70) and women (n = 70) in the Bardejov district. Probands were divided into groups depending on age (18–38, 39–50, 51–60, and over 61 years). For statistical evaluation, the program Statistica ver. 12 and ANOVA were used.

Results: The results of the study showed statistically significantly higher values of BMI, total cholesterol (TC), triacylglycerides (TG), and glucose (GLU) ($p < 0.001$) between men and women in the age groups (18–38 years, 39–50 years). In probands from the age group 51–60 years and over 61 years, we found a high level of cholesterol above the reference limit, but a significant difference between men and women was not confirmed. Correlation analysis confirmed the positive correlation between glucose and BMI.

Conclusion: Differences in risk-factor (e.g., biochemical and anthropometrics) burden translate into marked differences in the lifetime risk of cardiovascular disease. These differences are consistent across age groups.

Key words: cardiovascular system biochemical parameters, anthropometric parameters, myocardial infarction

Address for correspondence: J. Poráčová, Department of Biology, Faculty of Humanities and Natural Sciences, University of Prešov, St. 17th November 1, 080 01 Prešov, Slovak Republic. E-mail: janka.poracova@unipo.sk

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INTRODUCTION

Overweight and obesity is characterized as a chronic metabolic disease that affects more than 50% of the population. In several European countries, it affects 21% of men and 31% of women. The results of studies show that over the last 10 years the number of obese people has increased to such an extent that obesity affects 150 million Europeans. This is why the World Health Organization (WHO) has labelled obesity the pandemic of the 21st century (1). Ischaemic heart disease (IHD) is a worldwide problem that appears because of poor lifestyle, improper lifestyle, hereditary predispositions, and external factors. The most common cardiovascular diseases (CVD) include myocardial infarction (MI), angina pectoris, hypertension, atherosclerosis, endocarditis, atrial fibrillation, myocarditis, pericarditis, and chronic heart failure (2). In the area of overall mortality and morbidity, cardiovascular diseases occur predominantly in Slovakia and in Europe. Over the last period, mortality from coronary heart disease (35%), stroke (26%), kidney failure (82%), heart hypertension (48%), and diabetes mellitus has increased by up to 93% (3).

In general, every fourth man (26%) and every fourteenth woman (7%) die prematurely from diseases of the circulatory system. The male-female mortality imbalance is most unfavourable in the 20–30 years age group, with male mortality accounting for 80% percent of all deaths (4). According to statistical data, cardiovascular diseases are the cause of shortened life expectancy in men by 6.6 and in women by 4.9 years of life. Among the risk factors of these diseases, we include diabetes mellitus, smoking, obesity, increased blood pressure and increased total cholesterol. These factors occur in more than one third to half of adults in vari-

ous districts of Slovakia (5). Based on several statistical analyses, the prognosis of cardiovascular diseases is generally negative, and the incidence of these diseases in women is gradually equalling the incidence in men (6). Regular physical activity, sound nutrition, weight management, and not smoking cigarettes have all been demonstrated to significantly reduce the risk of CVD (7). Currently, there are several ways to control and protect the cardiovascular system. In our work, we focused on determining selected biochemical (triacylglycerols, cholesterol and glucose) and anthropometric parameters (weight, height, BMI), which are important biomarkers of cardiovascular diseases.

MATERIALS AND METHODS

In the work, we measured the values of biochemical and anthropometric parameters in probands from peripheral and specialized outpatient clinics in the Bardejov District. Monitored parameters were obtained from preventive examinations in healthy and unrelated individuals; 140 probands were included in the experiment, of which 70 were men and 70 were women. We classified the group of these probands into four categories based on age (18–38 years, 39–50 years, 51–60 years, and over 61 years) (Table 1). Anthropometric measurements included height (cm) and weight (kg) to calculate BMI (kg/m^2) (Table 2). The BMI of these probands was calculated from their body weight and height using a universal formula. The Centers for Disease Control and Prevention (CDCs) state that there are four main levels of BMI: under 18.5 is considered underweight; 18.5 to 24.9 is a normal or healthy weight; 25.0 to 29.9 is overweight; and 30.0 or over is obese. Body weight and height measurements were taken without shoes, and the participants used lightweight clothing. This measurement was recorded to the nearest 0.1 kg SECA 700.

Table 1. *Division of probands (N = 140)*

Age (years)	Females n = 70 n (%)	Males n = 70 n (%)	Probands
18–38	35 (25.00)	35 (25.00)	70
39–50	7 (5.00)	10 (7.15)	17
51–60	10 (7.15)	13 (9.28)	23
61+	18 (12.85)	12 (8.57)	30

Table 2. *Comparison of variables between women and men (N = 140)*

Variable	Females n = 70 Mean (SD)	Males n = 70 Mean (SD)	p-value
Height (cm)	165.21 (5.43)	175.26 (8.07)	< 0.001
Weight (kg)	56.83 (5.73)	67.46 (13.18)	< 0.001
BMI (kg/m^2)	20.79 (2.33)	21.77 (2.83)	0.118
Glucose (uU/ml)	4.29 (0.80)	4.02 (0.48)	0.096
Total cholesterol (mmol/L)	5.12 (0.86)	4.83 (0.77)	< 0.001
Triglycerides (mmol/L)	1.51 (1.15)	1.81 (1.23)	< 0.001

SD – standard deviation; statistical significance p < 0.05

Blood samples (7.9 ml) were collected from probands in EDTA-containing vacutainer tubes. The blood samples were centrifuged for 15 min. at 15,000 rpm to extract serum. A biochemical analyser Cobas Integra 400 Plus (Roche, Germany) was used to measure serum glucose [mmol/L] (GLU), total cholesterol [mmol/L] (TC) and triglycerides [mmol/L] (TG).

The results of the work were statistically processed using the program Statistica ver. 12. Comparison was made using the parametric unpaired Mann-Whitney U-test and ANOVA test. Correlograms were created using regression analysis.

RESULTS

The obtained biochemical parameters of the probands were processed and evaluated (Table 3). We present a numerical, percentage and statistical representation of the individual biochemical parameters. In the first group of 18–38 years old probands, only 2 women (6%) and 5 men (14%) were overweight. Malnutrition affected 4 women (11%) and 5 men (14%). Neither men nor women suffered from obesity in this age category. The average value of BMI for women in the age group 18–38 years was 19.79 ± 2.33. The average value of BMI in men of 22.78 ± 2.83 in the same age group was significantly higher ($p < 0.001$).

We also found a statistically significant difference ($p < 0.001$) in the average BMI value between men and women in the age group of 39–50 years, the BMI value for women was 25.25 ± 2.63 and for men 27.73 ± 2.65. The BMI index values for the men and women aged 39–50 were as follows: 5 women out of 7 (71%) and 4 men out of 10 (40%) were overweight. Normal weight was observed in 2 women (29%) and 3 men (30%). Only 3 men (30%) and no women had grade 1 obesity. The BMI index values for men and women aged 51–60 were not statistically confirmed ($p = 0.804$) and were as follows: overweight affected 6 women out of 10 (60%) and 5 men out of 13 (39%). Obesity of the first degree affected 10% of the women and 15% of the men; 10% of the women and 15% of the men suffered from obesity of the third degree. In the group aged 61 and over, 9 women out of 18 (50%) and 6 men out of 12 (50%) suffered from obesity; 6% of the women and 8% of the men had a normal weight. First degree obesity affected 2 women (11%) and 5 men (42%). Second degree obesity affected 6 women (33%). Even in this age group, no significant difference ($p = 0.244$) was found between men and women in the BMI value.

According to our research sample, which consisted of probands aged 18–38 years, we found that 29 women out of 35 (83%) and 25 men out of 35 (71%) had a normal weight, while 5 men out of

Table 3. *Body mass index values of groups depending on age and gender (N = 140)*

Age (years)	Females Mean (SD)	Males Mean (SD)	p-value
18–38	19.79 (2.33)	22.78 (2.83)	< 0.001
39–50	25.25 (2.63)	27.73 (2.65)	< 0.001
51–60	28.45 (6.62)	29.01 (8.54)	0.804
61+	31.67 (4.89)	29.31 (2.68)	0.244

SD – standard deviation; statistical significance p < 0.05

35 (14%) were overweight. The value of the BMI index showed a level of statistical significance ($p < 0.001$) between the age category of 20 and under men with the age categories of 39–50, 51–60 and 61 and over men. In the age category from 39–50 years, overweight was confirmed in 5 women out of 7 (71%) and in 4 men out of 10 (40%). Furthermore, the results showed that 3 men out of 10 suffered from obesity of the first degree in the given age range, which represents 30%. At the age of 51–60, we recorded excess weight in 6 out of the 10 women, and this represents 60%. Among men, overweight was manifested in 38%, which represents 5 men out of 13. In the last age category 61 years and over, overweight was confirmed in 50% of the men and women.

Obesity of the first type appeared in 11% of the women and 42% of the men. According to our results, obesity of the second type affected only the women (33%) in the given age category. According to the results of the analysis of foreign authors, it is proven that all degrees of obesity appear in the adult population between the ages of 35–65 (8). Menotti et al. (4) stated that obesity affects 21% of men and 31% of women in several European countries. From the obtained results, we can conclude that the values of the analysis were also confirmed in our research sample of probands. All types of obesity were manifested in the sample of adult probands. The assumptions that obesity is mostly suffered from by women were also confirmed.

Table 4 shows the average value of cholesterol. In the age category from 18 to 30 years, normal concentration of triacylglycerols occurs in 35 women (100%) and in 31 men out of 35 (89%). High concentration of TG was observed only in 3 men (8%). In the category of 39–50 years old, we found a normal TG concentration in 5 women out of 7 (71%) and in 8 men out of 10 (80%). We found an increase in concentration in 29% of women and 10% of men. In 51–60 years old probands, a normal TG value occurred in 9 women out of 10 (90%) and 9 men out of 13 (69%). Elevated TG value occurs in 8%. We recorded a very high concentration of TG in 10% of the women and 15% of the men. In the age category over 61 years, normal TG values occurred in 15 women out of 18 (83%) and in 9 men out of 12 (75%); 6% of the women and 8% of the men had an increase in TG concentration. High TG values were found in 2 women (11%) and 2 men (17%). We did not record very high TG values in the given group of probands. In triacylglycerol measurements normal TG values were confirmed in all our examined samples in both sexes. The only deviation was the age category of 51–60 years, where we recorded a very high level of TG in women in 10% and in men in 15%. We noted a statistically significant difference ($p < 0.001$) in the average value of triglycerides between men and women in the age group 18–38 years and in the group 39–50 years. The value of TG in the group 51–60 years ($p = 0.128$) and 61+ years ($p = 0.050$) was not statistically significant.

For a healthy person, the level of total cholesterol is a maximum of 5 mmol/L of blood. LDL cholesterol should not exceed the level of 3 mmol/L blood in a healthy individual. According to doctors, the value of HDL cholesterol should exceed the level of 1 mmol/L of blood. They say a balanced diet, physical activity, and adequate body weight are the main conditions for maintaining cholesterol levels at normal values (9). According to other research, the ratio of total cholesterol to HDL cholesterol is no higher than 5.0. A long-lasting increase in cholesterol in the blood creates suitable conditions for the development of atherosclerosis (10).

In the age category 18–38 years, normal cholesterol concentration prevailed in 31 women out of 35 (89%) and 31 men out of 35 (89%). The risk of increased cholesterol concentration was found in 3% of the women. Based on the evaluation of 39–50 years old probands, we found that normal cholesterol concentration does not occur in the examined sample in women. In the selected men, the normal cholesterol concentration was 80%. We observed an increase in cholesterol concentration in 5 women. In the age category of 51–60 years old, we saw that increased cholesterol concentration concerned 6 women out of 10 (60%) and 3 men out of 13 (23%). At the same time, we saw that 4 women (40%) and 6 men (54%) had a normal cholesterol concentration. We found that the risk of increased cholesterol concentration affected 23% of the men. Normal cholesterol concentration at the age of 61 and over is found in 14 women out of 18 (78%) and 10 men out of 12 (84%). An increase in cholesterol concentration affected 16% of the women and 8% of the men. In 6% of the women and 8% of the men, we noted the risk of increased cholesterol concentration.

The value of normal cholesterol should not be greater than 5 mmol/L (7). According to the WHO, the average value of cholesterol in women is from 5.6–6.1 mmol/L (10). This represents an increased or risky value of cholesterol. In the age category 39–50 years, none of the 7 women had a normal cholesterol value. As many as 5 of the women (71%) had an elevated value, 2 of the women (29%) even had a cholesterol risk value. Likewise, in the age category 51–60, 6 of the women had an increased cholesterol value (60%). We noted a statistically significant difference ($p < 0.001$) in the average cholesterol value between men and women in the age group 18–38 years and in the 39–50 years group. The cholesterol value in the 51–60 years ($p = 0.628$) and 61+ years ($p = 0.760$) groups was not statistically significant (Table 5). In the age category 18–38, a normal glucose concentration was found in 34 women out of 35 (97%) and 35 men (100%). Some risk of increased concentration concerns 1 woman (3%). An increased concentration of glucose was not detected in the observed men.

Table 4. *Triacylglycerol values of groups depending on age and gender (N = 140)*

Age (years)	Females Mean (SD)	Males Mean (SD)	p-value
18–38	0.75 (0.29)	1.18 (0.54)	< 0.001
39–50	1.75 (0.82)	1.80 (1.02)	< 0.001
51–60	2.02 (2.47)	2.03 (1.67)	0.128
61+	1.54 (1.02)	1.89 (1.41)	0.050

SD – standard deviation; statistical significance $p < 0.05$

Table 5. *Cholesterol values of groups depending on age and gender (N = 140)*

Age (years)	Females Mean (SD)	Males Mean (SD)	p-value
18–38	4.11 (0.58)	4.33 (0.72)	< 0.001
39–50	4.85 (0.52)	6.17 (0.92)	< 0.001
51–60	5.24 (1.21)	5.16 (0.52)	0.628
61+	4.72 (0.73)	4.57 (1.18)	0.760

SD – standard deviation; statistical significance $p < 0.05$

In the category of 39–50 years old probands, we recorded normal glucose values in 5 women (71%) and 4 men (40%); 29% of the women and 50% of the men showed increased glucose concentration. An increase in glucose concentration concerned 10% of the men. In the category of 51–60 years old probands, increased glucose concentration was measured in 7 women (70%) and 4 men (31%). Normal glucose concentration occurred in 2 women (20%) and 5 men (38%). We see that increased glucose concentration is present in 1 woman (10%) and 4 men (31%). In the age category of 61 years and older, normal glucose concentration occurred in 6 women (34%) and in 4 men (33%). Increased concentration of glucose level concerns 6 women (33%) and 3 men (25%). Based on our findings in the given age range, an increase in glucose concentration occurred in 6 women (33%) and 5 men (42%). Glucose concentration in the age category of 18–38 years was normal for women and men. In the age category of 39–50 years, an increased value of glucose was confirmed in 5 men (50%). We also found a risk value of glucose in 1 men (10%), while 5 women (71%) had a normal value. We found a statistically significant difference ($p < 0.001$) in the average glucose level between men and women in the age groups 18–38 years and 39–50 years (Table 6). A significant difference was not found in the 51–60 years ($p = 0.077$) and 61+ years group ($p = 0.932$), but the glucose value is markedly higher than the reference value in both sexes. The average concentration of glucose in the fasting blood of healthy people is 3.6–6.1 mmol/L. Elevated values may indicate the possibility of diabetes mellitus, acidosis, infection, acute inflammation, CO poisoning, etc., (6).

Table 6. *Glucose values of groups depending on age and gender (N = 140)*

Age (years)	Females Mean (SD)	Males Mean (SD)	p-value
18–38	4.88 (0.83)	3.99 (0.41)	< 0.001
39–50	5.02 (0.99)	5.95 (0.91)	< 0.001
51–60	8.82 (3.26)	6.28 (2.18)	0.077
61+	7.04 (3.11)	7.60 (3.53)	0.932

SD – standard deviation; statistical significance $p < 0.05$

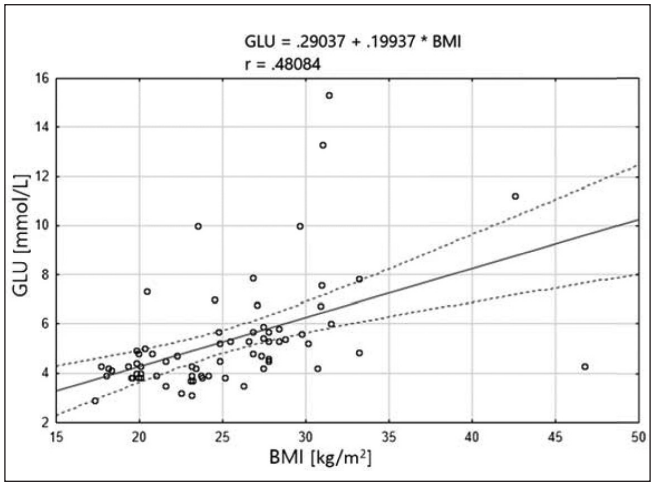

Fig. 1. *Relationship between BMI value and glucose in the total set of men (r = 0.481).*

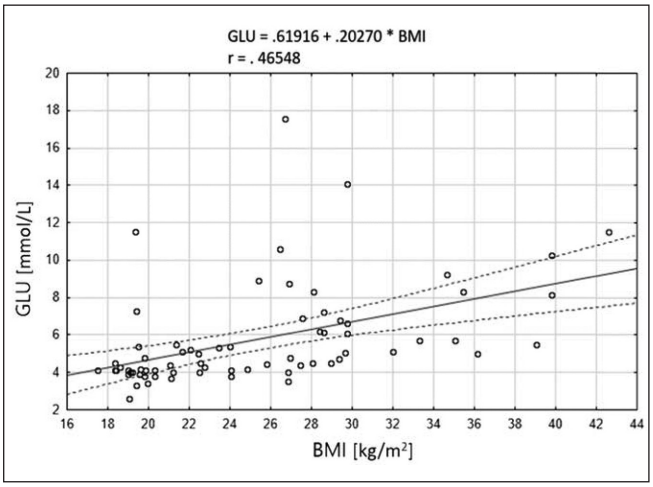

Fig. 2. *Relationship between BMI value and glucose in the total set of women (r = 0.465).*

Through a correlation analysis, we confirmed a positive relationship between BMI values and glucose level in the group of men ($r = 0.481$) and in the group of women ($r = 0.465$). With increasing BMI values, glucose levels increased in males and females (Fig. 1 and 2).

DISCUSSION

Obesity is a public health problem that has spread worldwide. It is important to focus on the development and implementation of obesity-promoting factors, as well as barriers to lifestyle change at personal, environmental, and socioeconomic levels, or to actively involve different levels of stakeholders and other major parties. It often happens that a person can have a normal BMI, but you have low muscle mass and a lot of fat, which is an unhealthy condition. On the other hand, a person may be very muscular and therefore inaccurately classified as overweight according to another study (11). BMI provides us with a great deal of obesity statistics, with approximately 70% of adults known to be overweight or obese (12). Similarly, 1 in 6 children and adolescents are considered obese according to the CDCs (13). Other undesirable complications go hand in hand with obesity, in the form of a higher risk of cardiovascular diseases, stroke, type 2 diabetes, and many others, which can lead to further morbidity and mortality of the individual. The risk of certain types of cancer is also greatly underestimated. The National Cancer Institute notes that higher amounts of body fat are associated with cancer, including endometrial, oesophageal, liver, kidney, pancreatic, colorectal, breast, ovarian, and thyroid cancers (14). Another negative impact is brain function, according to a study by Hamer and Batty. They claim that a person with a BMI greater than 30 (considered obese) or a higher waist-to-hip ratio (also known as more belly fat) may have lower brain volume than leaner adults, with brain shrinkage linked to cognitive decline (15). Another nuisance that obesity affects is sleep. It can cause poor quality, which leads to fatigue, destroys healthy habits, and makes people more overweight. High blood pressure, high cholesterol, depression, anxiety, and pain are other problems associated with obesity, according to the CDCs.

Cholesterol and triacylglycerols are among the most important lipids in the human body. From the point of view of chemistry, triacylglycerols are esters of fatty acids with glycerol, they are also referred to as neutral fats. They enter the human body through ingested food, while part of the triacylglycerols transform into immediate energy. If the organism does not have a high energy expenditure, they are stored in fat tissues as an energy reservoir. If necessary, they are released from fat cells and subsequently serve as an energy source. If a person does not exercise or expend energy, triacylglycerols are not consumed and remain stored. Most of it is found in the fat layers under the skin and around the vital organs it protects. Elevated levels of triacylglycerols also increase the risk of cardiovascular diseases (heart attack, stroke, and many others). According to scientists, higher levels of triacylglycerols contribute to the development of cardiovascular diseases such as myocardial infarction and stroke (10). Hypertriglyceridemia most often occurs with excess weight, diabetes, atherosclerosis, reduced thyroid function, and a diet rich in fats. At the same time, excessive alcohol consumption, hereditary predisposition, kidney, and pancreatic diseases can also function as triggers (16). According to the recommendation of the European Society, the concentration of triacylglycerols in the blood serum is up to 2.3 mmol/L in the reference range. If it ranges from 2.3–5.2 mmol/L, it is elevated or borderline. A value exceeding 5.2 mmol/L is high and risky. A high concentration of triacylglycerols and total cholesterol acts as a negative factor that should be avoided through a healthy lifestyle.

A cholesterol level plays an important role in the process of cardiovascular diseases. Lipids, such as cholesterol or triglycerides, are absorbed from the gut and transported throughout the body via lipoproteins for energy, steroid production, or bile acid production.

They circulate as lipoproteins, which are composed of non-esterified cholesterol, triglycerides, phospholipids, and proteins. There are five basic lipoproteins in the blood: chylomicrons, very low-density lipoprotein (VLDL), intermediate-density lipoprotein (IDL), low-density lipoprotein (LDL), and high-density lipoprotein (HDL). Each of these classes of lipoproteins carries cholesterol and triglycerides to their designated locations. Dyslipidaemia is a condition that means an imbalance of lipids in general, while the term hyperlipidaemia describes a high level of lipids – cholesterol in the blood, which causes the risk of developing atherosclerotic cardiovascular disease. The cholesterol value is measured and determined from serum (17).

The prevalence of dyslipidaemia, according to Pappan and Rehman, increases with age. From 2005–2008, an estimated 33.5% of US adults over the age of 20 had high LDL-C levels. Of these individuals with elevated LDL-C levels, only 48.1% received treatment and 33.2% had LDL-C controlled. The prevalence of LDL-C control appeared to be lowest among individuals who had incomes below the poverty level (18).

CONCLUSIONS

The reasons why someone is overweight, suffers from obesity (high body mass index), high level of glucose, cholesterol, or triacylglycerols in the blood are multifactorial. However, there is prevention, thanks to which it is possible to avoid such situations. The most significant effect can be achieved by the right lifestyle, how often and especially what we consume, how much physical activity we perform during the day. Healthy nutrition and exercise delay the onset of many diseases, prolong the quality of life, and give a feeling of subjective well-being and satisfaction.

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Conflicts of Interest

None declared

REFERENCES

1. Hruby A, Hu FB. The Epidemiology of obesity: a big picture. Pharmacoeconomics. 2015 Jul;33(7):673-89.
2. Horáková K. [How to have a healthy heart and blood vessels at any age]. Bratislava; 2015. Slovak.
3. Murín J, Pernický M, Compagnon R, Macháčová M. [Heart failure and atrial fibrillation - freguent and bad disease combination]. Intern Med. 2016;16(6):258-61. Slovak.
4. Menotti A, Lanti M, Puddu PE, Kromhout D. Coronary heart disease incidence in northern and southern European populations: a reanalysis of the seven countries study for a European coronary risk chart. Heart. 2000 Sep;84(3):238-44.
5. Kamenský G, Pella D. [Healthy lifestyle: Path to the prevention of heart and vascular diseases]. Bratislava: AEPress; 2010. Slovak.
6. Rodgers JL, Jones J, Bolleddu SI, Vanthenapalli S, Rodgers LE, Shah K, et al. Cardiovascular risks associated with gender and aging. J Cardiovasc Dev Dis. 2019 Apr 27;6(2):19. doi: 10.3390/jcdd6020019.
7. Rippe JM. Lifestyle strategies for risk factor reduction, prevention, and treatment of cardiovascular disease. Am J Lifestyle Med. 2018 Dec 2;13(2):204-12.
8. Alsulami S, Baig M, Ahmad T, Althagafi N, Hazzazi E, Alsayed R, et al. Obesity prevalence, physical activity, and dietary practices among adults in Saudi Arabia. Front Public Health. 2023 Mar 28;11:1124051. doi: 10.3389/fpubh.2023.1124051.
9. Scheidt-Nave C, Du Y, Knopf H, Schienkiewitz A, Ziese T, Nowossadeck E, et al. [Prevalence of dyslipidemia among adults in Germany: results of the German Health Interview and Examination Survey for Adults (DEGS 1)]. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz. 2013 May;56(5-6):661-7. German.
10. Schusterová, I. et al. [Obesity and its effects on the cardiovascular system in childhood]. Martin: Osveta; 2012. Slovak.
11. Etchison WC, Bloodgood EA, Minton CP, Thompson NJ, Collins MA, Hunter SC, et al. Body mass index and percentage of body fat as indicators for obesity in an adolescent athletic population. Sports Health. 2011 May;3(3):249-52. doi: 10.1177/1941738111404655.
12. Kotsis V, Martinez F, Trakatelli C, Redon J. Impact of obesity in kidney diseases. Nutrients. 2021;13(12):4482. doi:10.3390/nu13124482.
13. Sanyaolu A, Okorie C, Qi X, Locke J, Rehman S. Childhood and adolescent obesity in the United States: a public health concern. Glob Pediatr Health. 2019 Dec 1;6:2333794X19891305. doi: 10.1177/2333794X19891305.
14. Pati S, Irfan W, Jameel A, Ahmed S, Shahid RK. Obesity and cancer: a current overview of epidemiology, pathogenesis, outcomes, and management. Cancers (Basel). 2023 Jan 12;15(2):485. doi: 10.3390/cancers15020485.
15. Hamer M, Batty GD. Association of body mass index and waist-to-hip ratio with brain structure: UK Biobank study. Neurology. 2019 Feb 5;92(6):e594-600. doi: 10.1212/WNL.0000000000006879.
16. Burkhardtová D. [Laboratory values]. Bratislava: NOXI; 2007. Slovak.
17. Lee Y, Siddiqui WJ. Cholesterol levels. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
18. Pappan N, Rehman A. Dyslipidemia. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023.
19. John GK, Mullin GE. The Gut microbiome and obesity. Curr Oncol Rep. 2016 Jul;18(7):45. doi: 10.1007/s11912-016-0528-7.
20. Fruh SM. Obesity: Risk factors, complications, and strategies for sustainable long-term weight management. J Am Assoc Nurse Pract. 2017 Oct;29(S1):S3-14.

21. Spivey A. Lose sleep, gain weight: another piece of the obesity puzzle. Environ Health Perspect. 2010 Jan;118(1):A28-33. doi: 10.1289/ehp.118-a28.
22. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015 Mar;1(1):40-3.
23. Scott KA, Melhorn SJ, Sakai RR. Effects of chronic social stress on obesity. Curr Obes Rep. 2012 Mar;1(1):16-25.

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