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PROS AND CONS OF A HIGH-PROTEIN DIET

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Relevance. *In recent years, the nature of human nutrition as an important element of prevention and therapy of many pathological conditions, primarily obesity, type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVD), has become increasingly relevant. Some of the most popular nutrition models are high-protein diets, among which the Dukan diet has received the greatest recognition. Increasing the proportion of protein in the diet has shown an effective reduction in body weight, primarily due to the loss of adipose tissue, without a significant effect on muscle mass. Another advantage of a high-protein diet is the formation of an earlier and longer-lasting feeling of satiety compared to other diets, which makes it comfortable to use. In addition to obesity, a high-protein diet is presumably effective in the treatment of diseases such as non-alcoholic fatty liver disease, T2DM and CVD. However, despite the important advantages, this nutrition model is not universal and is contraindicated in a number of liver diseases, kidneys, and osteoporosis. In addition, long-term adherence to a high-protein diet, even by healthy individuals, can become a risk factor for developing urolithiasis and reducing bone mineral density. Thus, increasing the proportion of protein in the diet should only occur under the supervision of a physician.*

KEYWORDS: *high protein diet; protein, kidneys; muscles; diabetes; cardiovascular disease.*

INTRODUCTION. The nature of human nutrition as part of the prevention and treatment of obesity, as well as associated diseases, primarily type 2 diabetes mellitus (T2DM) and cardiovascular diseases (CVD), is becoming increasingly important every year [1]. The benefits and possible negative consequences of some diets, such as the

Mediterranean or Dukan diets, have been relatively well studied. Others, on the contrary, have a weak evidence base and an ambiguous prognosis, since they are largely based only on hypotheses and assumptions about their impact on human health, although they are actively used by the population, including for the purpose of weight loss. Literally 10-15 years ago, the main recommendation for weight loss was to reduce fat intake in the diet. However, at present, on the contrary, high-protein diets are among the most popular dietary models [2]. The question of what amount of protein should be considered optimal and what is increased remains open. Physiological factors that determine the daily protein requirement are: the rate of absorption of amino acids in the gastrointestinal tract (varies from 1.3 to 10 g/h depending on the protein source), the ability of the liver to form urea, and the rate of excretion of urea by the kidneys.

There are three ways to measure your daily protein intake:•

share of total daily caloric intake (%);

• absolute (g/day);

• calculated based on body weight (g/kg/day).

Each of the proposed options has its pros and cons. The share of protein in the total daily energy value can be easily calculated independently. However, this method is not universal, and in some situations, for example, when following a hypo- or hypercaloric diet, its use is controversial. In the first case, the daily dose of protein may be insufficient to meet the physiological needs of the body, and in the second - excessive and have a toxic effect. A similar problem arises when the amount of protein is measured in grams and equals a specific figure. People with different weights, especially if this is due mainly to muscle mass, will have different protein needs. Thus, the most optimal method is an individual calculation in grams per kilogram of body weight per day under the supervision of a nutritionist [3]. In addition to quantity, the origin of the protein is important. There are various classifications of protein quality [4]. DIAAS (Digestible Indispensable Amino Acid Score) is a method for assessing the nutritional value of food proteins, taking into account their source and the content of essential amino acids. It is calculated as the ratio between the amount (mg) of digestible essential amino acid in 1 g of the test protein and the amount (mg) of the same amino acid in 1 g of the control protein. DIAAS may have values below or, under certain circumstances, above 100% [5]. Animal protein, rich in essential amino acids, is of the highest quality, while plant proteins (except soy) are characterized by moderately low quality [6]. According to the US National Institutes of Health, the protein dose for a person without significant muscle loads is 0.8 g / kg / day [7]. However, the norm may differ for certain categories. For example, people with well-developed muscles need more protein. Due to age-related loss of muscle mass, the daily protein dose in the elderly should be at least 1.0-1.3 g / kg / day. At the age over 50 years and in the presence of acute or chronic diseases (except for kidney and liver

pathology), the need for protein increases to 1.2–1.5 g/kg/day [8, 9]. On the other hand, it is important to remember that excessive protein intake – up to 5 g/kg/day, typical for athletes and bodybuilders, may exceed the liver's ability to convert excess nitrogen into urea and be potentially dangerous for the body at any age [3]. Some authors believe that the daily protein requirement for a person with normal body weight should be revised upwards. Bilsborough S. et al. suggest considering the protein intake of 2.0–2.5 g/kg/day as normal, which, in their opinion, will not only satisfy the body's needs, but will also contribute to weight control without undesirable toxic effects. Morales FE et al. It is believed that the optimal amount of protein is 1.5–2.0 g/kg/day, which is almost 2 times more than Russian recommendations [3].Similar figures are cited by Canadian nutritionists and the American College of Sports Medicine (1.2–2.0 g/kg/day) [10, 11]. Since the opinions of researchers regarding the daily protein intake differ, the concept of a "high-protein diet" has not yet been defined. Various sources define a high-protein diet as one in which 27 to 68% of daily calories come from protein or protein intake ranges from 90.5 to 284 g/day, or from 1.2 to 4.4 g/kg/day [12, 13]. The most popular model of a high-protein diet over the past 10 years has been the Dukan diet, which includes 4 phases. During the first two, weight loss occurs, and the next two stabilize the result. A prerequisite before starting to eat according to the Dukan system is to determine your true weight. The calculation is based on gender, age, maximum and minimum weight throughout life, desired weight, family history of obesity, bone mineral density and the number of pregnancies in women. The resulting figure, according to Dukan, is the true weight that can be maintained for a long time without any restrictions, physical and emotional discomfort. The cornerstone of the Dukan diet is 100 permitted products. This list includes: 68 protein products (lean meat, fish, seafood, vegetable proteins, low-fat dairy products), 32 types of vegetables and oat bran. Physical exercise is included in each phase of the method and should be individually adapted. The minimum requirement is daily walking plus the type of activity chosen by the patient (aerobics, cycling, swimming, dancing, fitness, etc.). Below - more details about each of the stages of the Dukan diet. • Phase I - attack. Rapid weight loss is achieved by consuming 68 animal protein products in unlimited quantities. It is also recommended to drink 6 to 8 glasses of water per day, since digesting large amounts of protein leads to an increase in the level of ketones, which are excreted from the body in the urine. In addition, oat bran as a source of fiber and carbohydrates should be a mandatory component of the diet. Walking at an individual comfortable level is recommended as physical activity. The factors that determine the duration of the first phase are age and the weight to be lost. If the goal is to reduce body weight by less than 5 kg, the attack phase will take 1-2 days, 6-13 kg - from 3 to 5 days, more than 14 kg - up to 7 days, respectively. • Phase II - alternation. The goal of the

second stage is a gradual decrease in body weight until the desired weight is achieved. The second phase is based on alternating NP days (Natural Proteins), when only protein foods are allowed, with PV days (Proteins and Vegetables), during which 32 types of non-starchy vegetables can be added. NP days alternate with PV days in equal proportions. For example,1/1 means 1 day of pure protein, then 1 day of protein and vegetables, etc. Weight loss is gradual - on average 500 g every 3 days, mainly due to fat tissue. Physical activity is also an important part of the alternation phase, preference should be given to brisk walking for at least 30 minutes a day. • Phase III - consolidation. In the third stage, the main task is to maintain the weight achieved during the alternation phase. The basis of the diet remains 100 permitted proteins and vegetables, while high-calorie foods are gradually added. During the week, it is recommended to introduce a new group of products daily, which allows you to maintain motivation for a long time. One of the days remains purely protein, due to which, if necessary, you can adjust your weight. The duration of the third phase depends on how much body weight has decreased: for every 450 g - 10 days.

A rough outline of the consolidation phase might look like this.

• Monday: protein day.
• Tuesday: + unlimited vegetables.
• Wednesday: + fruits.
• Thursday: + wheat bread.
• Friday: + cheese.
• Saturday: + starchy foods (pasta, etc.).
• Sunday: Festive meal (aperitif (wine, etc.), appetizer, main course and cheese OR dessert; each course can only be eaten once).

As for physical activity, brisk walking for at least 30 minutes a day is still recommended. • Phase IV - stabilization. You are allowed to eat whatever you want, observing 3 simple rules: • one day of pure proteins each week; • 20 minutes of walking each day and refraining from using elevators and escalators; • 3 tablespoons of oat bran daily. This is the high-protein diet model proposed by Pierre Dukan [14]. The Stillman diet is also high-protein: proteins provide 64% of the daily caloric value (4.3 g / kg / day), and only 2% are carbohydrates. Given the strict restrictions in the diet - only lean meat (lamb, veal, etc.), fish (haddock, cod, etc.), eggs and cheese made from skim milk are allowed - the Stillman diet is recommended to be followed for a short period of time and only under the supervision of a doctor. The diet proposed by Arthur Agatston (or the South Beach Diet) is based on foods with a low glycemic index (GI), which are digested more slowly by the body and cause smaller fluctuations in blood glucose and insulin levels. Proteins make up about 39% of daily calories. It is recommended to mainly consume natural foods. The diet consists of 3 phases: Phase I - strict restriction of carbohydrates - lean meat, seafood, cheese, eggs, nuts are allowed; Phase II - a small

amount of low GI foods is introduced into the diet (some types of vegetables and fruits, whole grain bread and pasta, low-fat liquid dairy products); Phase III - almost all foods are included in the diet, with the exception of easily digestible carbohydrates. In the Zone Diet, the protein/fats/carbohydrates ratio is 30/30/40, preference is given to low GI foods and monounsaturated fats. Products are grouped into blocks based on macronutrient content. Each main meal consists of 3–5 blocks, snacks – one block. The limitations of this diet are the need to constantly count proportions and daily consumption of large amounts of vegetables [15]. Thus, despite the wide range of high-protein diets and their great popularity among those wishing to lose weight, it is important to remember that increasing the proportion of protein in the diet can lead to negative health consequences. Use in obesity An advantage of a high-protein diet may be that it results in weight loss mainly due to the loss of adipose tissue, without a significant effect on muscle mass [16]. In two studies, the first lasting 12 weeks and the second 6 months, participants followed a diet with a protein content of 0.8 g/kg/day and 1.2–1.4 g/kg/day, respectively. A decrease in body mass index (BMI) was observed in both groups, with muscle mass being higher in the second group [13, 17]. Longland TM et al. analyzed the combined effect of a high-protein diet and exercise on changes in body composition. Participants consumed 2.4 g/kg/day of protein for 4 weeks,while the control group followed a diet with a protein level of 1.2 g/kg/day. Both groups performed high-intensity training three times a week and walked 10,000 steps per day. At the end of the study, the BMI of all participants was significantly reduced. However, after analyzing the body composition, differences were revealed: against the background of increased protein intake, loss of fat tissue was predominant [18]. Another supposed advantage of a high-protein diet is an earlier and longer-lasting satiety compared to other diets, which not only contributes to weight loss, but also makes it comfortable for a person [19]. Based on the visual analog scale (VAS), which is a standard tool for measuring the subjective feeling of hunger and satiety, it was shown that the feeling of satiety is significantly higher with a diet with 60% protein than after a meal with 19% protein [20]. It is known that the feeling of hunger is formed as a result of the interaction of two groups of substances: anorexigens, which suppress appetite, and orexigens, which have the opposite effect. The main anorexigens are cholecystokinin (CCK), glucagon-like peptide 1 (GLP-1), peptide YY (PYY) and leptin; among the orexigens, ghrelin plays an important role [19, 21]. It is assumed that protein consumption controls appetite by influencing the production of an- and orexigens. Amino acids have been shown to stimulate the secretion of CCK, GLP-1 and PYY in the small intestine [21]. CCK causes contraction of the gallbladder and the release of pancreatic enzymes. In addition, it enhances the feeling of satiety by influencing the transmission of vagus nerve signals to the brainstem [22]. In an

experiment, intravenous administration of physiological doses of CCK was accompanied by a decrease in the portion of food eaten and faster satiety [23]. GLP-1 and PYY act similarly through the vagus nerve [22, 3]. A number of studies have shown that intravenous administration of PYY in doses corresponding to postprandial concentrations significantly reduces appetite [23]. In addition, PYY blocks the expression of orexigenic neuropeptide Y (NPY) and agouti-related peptide (AgRP) mRNA in the hypothalamus; improves glucose tolerance, accelerates thermogenesis and reduces the amount of white adipose tissue [21, 24]. It is noteworthy that PYY deficiency is observed in obese individuals [23]. GLP-1 slows down gastric emptying, which contributes to the formation of a longer feeling of satiety [25]. A similar effect of GLP-1 could be used to create a drug for weight loss, if not for the rapid half-life (1–3 min) due to destruction by the enzyme dipeptidyl peptidase IV, which greatly limits the clinical use of this molecule [26]. Unlike anorexigenic hormones, ghrelin levels decrease in response to protein consumption [27]. Ghrelin activates NPY and AgRP neurons in the arcuate nucleus, thereby causing a signal to increase food intake and decrease energy expenditure [28]. Leptin has the opposite effect, acting through PI3K (from the Englishphosphoinositide 3-kinases) and STAT3 (signal transducer and activator of transcription 3) [3]. Carbohydrates have the strongest, albeit short-term, suppressive effect on ghrelin production, while fat and protein cause a small but stable decrease. Blom et al. showed that after a high-protein meal, the feeling of satiety is significantly stronger, and the postprandial concentration of ghrelin decreases compared to an isocaloric meal rich in refined carbohydrates [29]. Interestingly, the specific response of ghrelin to macronutrient intake is observed only in people with normal weight, while in the presence of obesity it almost completely disappears [30, 31]. High-protein, low-carbohydrate diets promote gluconeogenesis in the liver in order to maintain normal plasma glucose levels, which, presumably, can also influence the formation of a more pronounced feeling of satiety. It is known that lowering blood glucose levels increases appetite, while amino acid-induced gluconeogenesis prevents hypoglycemia and has the opposite effect. In addition, the formation of ketone bodies (especially beta-hydroxybutyrate) increases in response to protein consumption, which also contributes to appetite suppression [32]. Another possible mechanism for weight loss during a high-protein diet is diet-induced thermogenesis (DIT). Food intake results in a temporary increase in energy expenditure, which is associated with nutrient processing (digestion, absorption, transport, and storage). DIT values are highest for protein (~15–30%), followed by carbohydrates (~5–10%) and fat (~0–3%) [33]. Whitehead et al. showed that energy expenditure was 297 kJ/day higher in individuals consuming a high-protein diet (36% of daily calories) compared to those consuming a diet rich in carbohydrates and fats. Mikkelsen et al. obtained similar results [32]. The

effects depend not only on the amount of protein, but also on its qualitative composition. Among amino acids, leucine has the greatest suppressive effect on food intake and stimulating effect on muscle protein synthesis [22, 34]. Leucine acts by inactivating AMP-activated protein kinase (AMPK) and activating the mammalian target of rapamycin (mTOR) in the hypothalamus. Activation of mTOR and deactivation of AMPK decreases the expression of NPY and AgRP, while increasing the release of the anorexigenic peptide proopiomelanocortin, which together create a feeling of satiety [22, 35]. An equally important effect of leucine is its participation in the regulation of mTOR activity in skeletal muscles, which increases muscle protein synthesis through insulin-dependent and insulin-independent mechanisms. This leads to better weight control in the long term [36]. Use in type 2 diabetes According to a meta-analysis of 18 studies,An increase in the proportion of protein in the diet in type 2 diabetes is associated with a significant decrease in the level of glycated hemoglobin [37]. As for the effects on the cardiovascular system, the data are ambiguous. Sargrad KR et al. compared blood pressure (BP) in two groups of patients: the first group followed a diet with a high protein content, the second - a normal diet. After 8 weeks, individuals in the first group showed a decrease in both diastolic (-18 mm Hg) and systolic (-10.5 mm Hg) BP compared with baseline values, while BP numbers in the second group remained unchanged [38]. Von Bibra et al. obtained similar results [39]. At the same time, other authors did not note any change in BP with an increase in the proportion of protein in the diet [40]. It is assumed that not only the amount, but also the origin of the protein are important. According to some data, red meat consumption is associated with adverse cardiovascular outcomes [41]. Sucher S. et al. showed that a diet with a higher protein content (30% of daily calories) reduces the severity of chronic inflammation and increases insulin sensitivity, which is accompanied by improved glycemic control. However, such positive effects were observed only against the background of a diet with a predominance of plant protein, but not animal protein [42]. The results of studies that examined the effect of diets with different protein content on lipid profile parameters (total cholesterol, high- and low-density lipoprotein cholesterol, triglycerides) are heterogeneous, and therefore further research is needed [40]. Data on the effects of a high-protein diet on renal function in type 2 diabetes are insufficient and contradictory. One study compared the effects of two diets (22 and 10% of daily calories from protein, respectively) in patients with type 2 diabetes and microalbuminuria on the glomerular filtration rate (GFR) and the severity of albuminuria. After 3 weeks, the parameters in patients in the first group remained unchanged, while the low-protein diet led to a significant decrease in GFR and albuminuria. Other studies, on the contrary, did not show significant changes in GFR, microalbuminuria, creatinine clearance, creatinine and urea levels in the blood against

the background of diets with different protein content [40]. There is also no clear opinion on whether the origin of protein affects renal function in patients with type 2 diabetes. Thus, Sucher et al. showed that the GFR remained stable regardless of which protein predominated in the diet - plant or animal [42]. Of interest are the results of a meta-analysis of Food4me data, according to which the consumption of plant proteins is associated with a reduced risk of developing T2DM, while the predominance of animal proteins in the diet, on the contrary, is a risk factor for its development [43]. Effect on the cardiovascular system The question of what type of nutrition is optimal for CVD remains open. Studies of the effects of high-protein diets on blood lipid levels,as the main risk factors for the development of atherosclerosis, show mixed results [37, 44]. In addition, there is no consensus on which protein - animal or plant origin - is preferable. It has been shown that with the consumption of predominantly plant protein (primarily soy), a more pronounced decrease in low-density lipoproteins, triglycerides, visceral fat volume and systolic BP is noted, while high consumption of red meat increases the risk of coronary heart disease and stroke [45–48]. Teunissen-Beekman et al. compared BP levels after consumption of pea, milk and egg protein, respectively. In response to egg protein, BP values were the highest [49]. Fekete AA et al., on the contrary, showed that cow's milk proteins have a lowering effect on BP and improve the arterial stiffness index [50]. In addition to the protein source, according to Tielemans et al., age is also important: increased intake of plant protein was inversely associated with BP only in elderly men [51]. Thus, further studies are needed to assess the benefit/risk ratio of high-protein diets in CVD. Use in non-alcoholic fatty liver disease The effect of a high-protein diet on patients with non-alcoholic fatty liver disease (NAFLD) remains controversial. According to some authors, a high-protein diet may have a therapeutic effect in NAFLD [52, 53]. Protein catabolism requires a large amount of energy, one of the sources of which may be ketogenesis in the liver [54, 55]. Glucagon, produced in response to protein intake, also stimulates ketogenesis and suppresses de novo lipogenesis [56]. In addition, a high-protein diet increases the synthesis of bile acids from cholesterol in hepatocytes [57]. All this leads to a decrease in fat infiltration and, as a consequence, the severity of NAFLD [58]. Zelber-Sagi S. et al., on the contrary, believe that animal protein increases the risk of developing NAFLD, in contrast to plant proteins [59]. Effect on bone mineral density Data on the effects of an increased proportion of protein in the diet on bone mineral density (BMD) are contradictory. Today, the problem of osteoporosis has become global - 1 in 4 women over 70 years of age experiences at least one fracture during their lifetime. In this regard, such available preventive measures as dietary modification are of paramount importance [60]. The supposed positive effect of a high-protein diet on BMD is realized due to the effect on calcium

absorption, bone metabolism and the production of insulin-like growth factor 1 (IGF-1). One of the important criteria increasing calcium absorption may be the stimulation of gastric juice secretion in response to protein food. Low pH of the stomach promotes calcium ionization and its subsequent absorption [61]. It has been shown thatthat patients with achlorhydria absorb less calcium than individuals with normal gastric pH. Another confirmation of this hypothesis is a significant decrease in calcium absorption after taking a proton pump inhibitor. In turn, the more calcium enters the body, the lower the response level of parathyroid hormone, which leads to a slowdown in bone resorption [23]. Isotope studies have shown greater calcium absorption in individuals whose diet contains an increased amount of protein [23]. During the study, participants adhered to a diet with a moderate (1.0 g / kg / day) and high (2.1 g / kg / day) protein level for 2 weeks. The results showed significantly greater intestinal calcium absorption and an increase in urinary calcium concentration in those who consumed more protein. At the same time, a significantly lower content of calcium in urine from bone tissue was found against the background of a high-protein diet. Therefore, hypercalciuria with an increase in protein intake is apparently associated with increased intestinal calcium absorption. It is known that the concentration of IGF-1 in the blood serum depends not only on the quantity but also on the quality of the consumed protein. It was found that higher levels of IGF-1 are observed in those who prefer animal proteins. The positive effect of IGF-1 on bone health has been confirmed by the results of a number of studies. IGF-1 increases the activity of osteoblasts, slows down the decline in BMD of the proximal femur in the elderly, and stimulates the growth of BMD in the spine and radius. A study involving 41,837 women aged 55–69 years revealed an inverse relationship between protein intake and the risk of hip fracture, confirming the important role of protein in nutrition [23]. Effect on the urinary system High-protein diets can be potentially dangerous for people with concomitant liver and kidney diseases, since they lead to excessive nitrogen intake into the body [3, 63]. In healthy individuals, increased protein intake is accompanied by an increase in the level of enzymes in the liver that break down amino acids, which compensates for the nitrogen load, while in liver diseases, an increase in the levels of amino acids, ammonia and urea in the blood may occur [3]. The removal of elevated, compared to a normal diet, concentrations of protein breakdown products necessitates an increase in the volume of fluid consumed. First of all, this is relevant for individuals with normal kidney function; in the presence of any diseases, the volume of fluid consumed is strictly individual. Martin WF et al. analyzed the relationship between the amount of protein consumed, the concentration of urea in the blood, plasma osmolality and the specific gravity of urine. During the study, the participants were divided into 3 groups: diet I contained 3.6 (high consumption), II - 1.8 (average) and III - 0.8 (low) g / kg /

day of protein, respectively. The participants adhered to their usual level of fluid consumption. According to the results,In group I, blood urea levels, plasma osmolality, and urine specific gravity were the highest [64]. An increase in SCF after consuming large amounts of protein is another indicator of increasing stress on the kidneys. In the long term, this can lead to kidney damage and a decrease in SCF, primarily in predisposed individuals. Huang MC et al. studied the effect of diet on SCF in a study of 599 adult patients diagnosed with stage 3–5 chronic kidney disease. It was found that individuals consuming a high-protein diet had a significant decrease in SCF compared to those consuming normal or low amounts of protein [65]. A high-protein diet may negatively affect the risk of kidney stones [66]. A link between high protein intake and the risk of developing or recurring urolithiasis (UB) was demonstrated in a study of healthy men on their usual diet with a four-year follow-up. Men consuming >77 g/day of animal protein showed a higher risk of developing urolithiasis than those whose diet contained 50 g of protein per day (1.33 vs. 1.00, respectively). It has been proven that limiting the consumption of animal protein, on the contrary, is one of the ways to prevent recurrent kidney stones [62]. It is assumed that the lithogenic effect is realized through several mechanisms. For example, by reducing the level of citrate in the urine. In addition, it has been shown that high consumption of animal protein is accompanied by an increase in the excretion of oxalates in the urine in about 30% of patients with idiopathic calcium nephrolithiasis, while in others such an effect is not observed. This susceptibility is apparently associated with genetic factors [62]. Thus, patients with an increased risk of kidney pathology (including diabetes, arterial hypertension and CVD) should be prescribed a high-protein diet with caution and exclusively under the supervision of a physician. In addition, it is important to remember that nephrolithiasis is a potential side effect of a high-protein diet, and therefore such dietary patterns are contraindicated in patients with a history of ICD. There is also insufficient data on the long-term impact of increased protein intake in older people, since SCF decreases with age. There is currently no evidence that a high-protein diet can negatively affect liver and kidney function in healthy individuals [67]. However, further research is needed to study this issue in more detail.In a study of 599 adult patients diagnosed with stage 3–5 chronic kidney disease, the effect of diet on SCF was studied. It was found that individuals consuming a high-protein diet had a significant decrease in SCF compared to those consuming normal or reduced amounts of protein [65]. A high-protein diet may negatively affect the risk of kidney stones [66]. An association between high protein intake and the risk of developing or recurring urolithiasis was demonstrated in a study of healthy men on their usual diet with subsequent observation for four years. Men consuming >77 g/day of animal protein showed a higher risk of developing urolithiasis than those whose diet contained 50 g

of protein per day (1.33 versus 1.00, respectively). On the contrary, limiting animal protein intake has been proven to be one of the ways to prevent recurrent kidney stones [62]. The lithogenic effect is believed to be mediated by several mechanisms. For example, by reducing urinary citrate levels. In addition, high animal protein intake has been shown to be associated with increased urinary oxalate excretion in approximately 30% of patients with idiopathic calcium nephrolithiasis, while no such effect is observed in others. This susceptibility appears to be associated with genetic factors [62]. Thus, patients at increased risk of renal pathology (including diabetes, hypertension, and CVD) should be prescribed a high-protein diet with caution and only under medical supervision. In addition, it should be remembered that nephrolithiasis is a potential side effect of a high-protein diet, and therefore such dietary patterns are contraindicated in those with a history of impaired ICD. There is also insufficient data on the long-term effects of increased protein intake in the elderly, since SCF decreases with age. There is currently no evidence that a high-protein diet can negatively affect liver and kidney function in healthy individuals [67]. However, further research is needed to study this issue in more detail.In a study of 599 adult patients diagnosed with stage 3–5 chronic kidney disease, the effect of diet on SCF was studied. It was found that individuals consuming a high-protein diet had a significant decrease in SCF compared to those consuming normal or reduced amounts of protein [65]. A high-protein diet may negatively affect the risk of kidney stones [66]. An association between high protein intake and the risk of developing or recurring urolithiasis was demonstrated in a study of healthy men on their usual diet with subsequent observation for four years. Men consuming >77 g/day of animal protein showed a higher risk of developing urolithiasis than those whose diet contained 50 g of protein per day (1.33 versus 1.00, respectively). On the contrary, limiting animal protein intake has been proven to be one of the ways to prevent recurrent kidney stones [62]. The lithogenic effect is believed to be mediated by several mechanisms. For example, by reducing urinary citrate levels. In addition, high animal protein intake has been shown to be associated with increased urinary oxalate excretion in approximately 30% of patients with idiopathic calcium nephrolithiasis, while no such effect is observed in others. This susceptibility appears to be associated with genetic factors [62]. Thus, patients at increased risk of renal pathology (including diabetes, hypertension, and CVD) should be prescribed a high-protein diet with caution and only under medical supervision. In addition, it should be remembered that nephrolithiasis is a potential side effect of a high-protein diet, and therefore such dietary patterns are contraindicated in those with a history of impaired ICD. There is also insufficient data on the long-term effects of increased protein intake in the elderly, since SCF decreases with age. There is currently no evidence that a high-protein diet can negatively affect liver and kidney function in

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CONCLUSION. To sum up, we can conclude that a high-protein diet is very effective and comfortable for weight loss in the short term. However, given the significant load on the kidney and liver function, a protein diet can only be recommended for certain categories of patients. An extensive list of contraindications necessitates switching to a high-protein diet exclusively under the supervision of a doctor and after undergoing an examination with monitoring of the condition in dynamics.

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