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ASSESSMENT OF NUTRITION AND NUTRITIONAL STATUS PARAMETERS IN HEMODIALYSIS PATIENTS

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ABSTRACT

Introduction. Hemodialysis patients' improper nutrition worsens prognosis and increases mortality. Adequate dietary recommendations and the care of a dietitian seem to be essential.
Aim. Assessment of nutrition and nutritional status parameters in hemodialysis patients without diet intervention and recommendation.
Material and methods. The research was carried out over two periods (stage I, in the summer time; stage II, in the winter time), included 32 people with chronic kidney disease (V stage, renal therapy ≥5 months): 18 women and 14 men, aged 26–79 years. We used the 24-hour diet recall, which was carried out for 7 days in each stage, and also an anthropometric measurement, BMI index, and the results of blood biochemical tests.
Results. We noticed too little energy, protein, fat, total carbohydrates, fiber, calcium, zinc, magnesium, iron, potassium, sodium, phosphorus, and vitamins A, D, E, B_1, B_2, B_6, B_{12}, C, folates, and niacin. Amounts of saturated fatty acid, cholesterol, and simple sugars were normal. The results were statistically significant for sodium and vitamin E. Normal values were for: white blood cells, platelets, total cholesterol, albumin and sodium, calcium, and potassium before and after dialysis (men, women). There was an increase in creatinine (men, women) and hemoglobin (women), and a decrease in red blood cells (women) and hematocrit (men, women). Urea's values were increased before dialysis and hemodialysis was effective for normalization of urea in the blood. The average values of glomerular filtration rate (GFR) were decreased. Average Kt/V index was normal. We found a positive correlation between protein intake and serum albumin levels ($R = 0.43$; $p < 0.05$).
Conclusions. Analysis showed that people using hemodialysis need proper diet, nutritional education, and in many cases, targeted supplementation.

Keywords: diet, nutritional assessment, nutrients, vitamins, kidney

INTRODUCTION

Hemodialysis is one of the renal therapy methods. According to the European and American recommendations, and also according to National Health Fund in Poland, qualification for this method of treatment is provided at the end-stage of renal disease, i.e., when the eGFR (estimated GFR) values for diabetics are <10 ml/minute, and for persons without diabetes <20 ml/minute (European Best Practice…, 2002; National Kidney Foundation…, 2002; Zdrojewski, 2008). Furthermore, the criteria for the use of this type of

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treatment are often defined as the symptoms of renal failure which are life-threatening, including: uremia, resistant hypertension, hyperkalemia without reaction to the applied pharmaceuticals, severe metabolic acidosis, high phosphatemia, deepening malnutrition, and overhydration (Zdrojewski, 2008).

Hemodialysis and peritoneal dialysis patients have an energy requirement of 30–35 kcal/kg/day and a protein requirement of 1.2 g/kg/day (Kalantar-Zadeh et al., 2011; National Kidney Fundation…, 2002). Authors indicate that this norm isn't met by the majority of patients (Kalantar-Zadeh et al., 2011; Gajewska et al., 2011; Kardasz and Ostrowska, 2012) and leads to protein-energy undernutrition (PEU) and increased mortality (Kalantar-Zadeh et al., 2011).

Many hemodialysis patients require the necessary supplementation with water-soluble vitamins, due to the losses caused by dialysis (Cano et al., 2006; Jankowska et al., 2014). The European Society for Clinical Nutrition and Metabolism (ESPEN) recommendations indicate the necessity of folic acid supplementation (1 mg/day) and supplementation with vitamin B6 (10–20 mg/day) and vitamin C (30–60 mg/day). Additionally, it's advisable to supplement with vitamin D in the case of incorrect serum values of calcium and phosphorus, as well as with incorrect values of parathyroid hormones. In some patients, supplementation with zinc (15 mg/day), and also with selenium (50–70 mg/day) is necessary. The indication for nutritional treatment is malnutrition, defined as a decrease in Body Mass Index (BMI) <20 kg/m^2, as well as decreased body mass >10% by time >6 months, reduced serum albumin <35 g/l, and prealbumin <300 mg/l (Cano et al., 2006). Due to the growing problems with hemodialysis patients' malnutrition, the aim of the study was to assess the diet and nutritional status of patients in order to determine the dietary management that supports the treatment process.

MATERIAL AND METHODS

The study included 32 people (18 women and 14 men) aged 26–79 years old, treated by renal therapy for 5–108 months (average 44 ±31 months/stage), 3 times/week, for 4–5 hours. Participants were patients of the Non-public Health Care Unit of the International Dialysis Center and agreed to participate in the study. Most of them were being treated with drugs for hypertension and diabetes, and used supplements: folic acid, B-group vitamins, vitamin C, E, and calcium (Ca). The research was conducted in two stages (summer and winter). The research was conducted according to the guidelines of the Declaration of Helsinki, and the protocol of the experiment was approved by the Ethics Commission at the University of Medical Sciences in Poznań.

The assessment of the participants' diets was performed using the 24-hour diet recall (carried out at each stage of the study for 7 days). We used the product and food photo album (Szponar et al., 2000) software Dietetyk 2 (nutrition calculator) and nutritional value tables of food products and dishes according to Kunachowicz et al. (2007). The supplementation has been included in the calculation of the nutritional value of the diet. The obtained values were compared to the standards for healthy people and dialysis patients (Cano et al., 2006), European Guidelines for Nutritional Care of Adult Renal Patients for hemodialysis patients recommendations (James and Jackson, 2003), and the Nutrition Standards for the Polish population (Jarosz et al., 2020). The calorific value of the diet was 35 kcal/kg IBW/day (IBW – ideal body weight), and protein value was estimated as a range of values: 1.2–1.4 g/kg IBW/day. The standards requiring conversion to ideal body weight (IBW) were determined on the basis of the average growth values and due population weight. The average body height for the population of our research was 167 cm, and the ideal body weight was 67 kg and was calculated using the Brock formula. The upper value of the standard was used to obtain the percentage of compliance with the standards (for sodium (Na) and phosphorus (P), it was the lower value of the standard). For magnesium (Mg), iron (Fe), zinc (Zn), vitamin A, vitamin E, vitamins B_1, B_2, B_6, niacin, and vitamin C, the range of standards was different for women and men, so a value was determined on the basis of a weighted average of the standards for each gender. Body height measurements, body weight assessment, and BMI, as well as the results of biochemical tests carried out at each stage of the study were used to assess the nutritional status.

In addition, we analyzed values of albumin, creatinine, urea before and after dialysis, total cholesterol (TCHOL), triglycerides (TG), P and also Na, potassium (K), and ionized Ca values before and after dialysis. Moreover, the evaluation of blood morphology was also performed: red blood cells-RBC, white blood cells-WBC, platelets-PLT, haemoglobin-HGB, and haematocrit-HCT. To assess this, we used an enzyme test with bromocresol green (the serum albumin content), an enzyme test with UV with urease and glutamate dehydrogenase (the urea content), the kinetic method with alkaline picrinate without deproteinization (creatinine), an enzyme fotometric test (total cholesterol), an enzyme and colorimetric test with the 3-phosphoglycerol oxidase (triglycerides), photometric UV test (phosphorus), and ion selective electrodes method (Na, K, ionized Ca). Additionally, GFR was calculated using a simplified MDRD formula (Wallach, 2011).

Blood biochemical tests were performed twice in each stage of the research using the Hitachi 912, Roche AVL 9180 analyser and the CELL-DYN 3700 system from ABBOTT. The Kt/V dialysis index was also tested using K-dialyzer clearance [l/min], t-haemodialysis time [min], and V-urea distribution volume (Alayoud et al., 2012), which was further used to calculate the delivered dialysis dose. For this purpose, the Daugirdas formula (including ultrafiltration) was used (Banach and Rysz, 2010; Sternby and Daugirdas, 2015).

For statistical evaluation, the dependent t-test (the paired t-test) was used (in order to assess the significance of the differences between stages I and II) and a rectilinear regression analysis was used (to assess the interdependencies between variables). Statistically significant results were those in which $p < 0.05$. Statistically significant results were marked with different letters in the Tables.

RESULTS AND DISCUSSION

In our research, we observed differences in values of BMI, but they were statistically insignificant. Underweight (BMI <18.5) was observed in 6% of our group at both stages. Normal weight had 56% (stage I) and 59% (stage II). Overweight had 19% of tested people (stage I) and 16% (stage II). In both stages, class I obesity was observed in 16% of tested people and class II obesity was observed in 3% of people. Class III obesity wasn't present in the studied population. In both stages, all patients were in V stadium of chronic kidney disease (CKD). The optimal value of BMI for a patient in V stadium of CKD is considered a BMI value between 23 and 36 kg/m^2 (Gajewska et al., 2011). The average values of patient BMI were at optimal values, indicating that people with both weight deficiency and overweight or obesity were present.

The study period didn't show a significant effect on energy consumption, nor on the content of protein, fat, cholesterol, saturated fatty acid (SFA), and monosaccharides (Table 1). However, the statistical analysis of nutritional value indicated the statistically significant difference in the case of consumption of carbohydrates between stage I and II. The highly significant statistical difference has been shown in the consumption of fiber. A statistically significant difference between consumption of energy and amounts of total carbohydrates in both stages was also reported. The proper energy intake and adequate proportion of protein, fat, and carbohydrates in the diet indicate a nephroprotective effect in patients with CKD (Kardasz and Ostrowska, 2012). It has been shown that there were significant deficiencies in the diet, which has also been reported in other studies (Gajewska et al., 2011; Kardasz and Ostrowska, 2012). The malnutrition and energy shortage in people with CKD, in particular people treated with supportive dialysis, is called uremic malnutrition (Kalantar-Zadeh et al., 2011), which has consequences from using protein as an energy source. It is unfavorable for patients with CKD because it leads to a lower survival rate of these patients (Kalantar-Zadeh et al., 2011; Kovesdy and Kalantar-Zadeh, 2009).

The participants in our study also didn't eat enough protein. Kardasz and Ostrowska (2012) have said that female hemodialysis patients with normal body weight consumed protein at 59.6% of the recommended standard, women with overweight and obesity at 59.5%, men with normal body weight at 97.2%, and men with overweight and obesity at 78.1% of recommended norms. In hemodialysis patients, PEU often occurs. The presence of PEU in the long term has a negative impact on the whole body, which contributes to an increase in the risk of cardiovascular disease (Yustea et al., 2013). Moreover, protein deficiency in the diet of these people positively correlates with a higher mortality rate. Most of the hemodialysis patients have an insufficient amount of energy and protein in their diet

Table 1. Assessment of the nutritional and energy value of hemodialysis patients' diets in relation to recommended norms [8, 12, 13, 22, 25]

Nutrients (daily consumption)	Indicators	Stage I	Stage II	Norms				
				Nutrition standards for the Polish population	ESPEN	NKF	European Guidelines for the Nutritional Care of Adult Renal Patients	European Best Practice Guidelines on Haemodialysis Part 2
1	2	3	4	5	6	7	8	9
Caloric value kcal/kg IBW	average ±SD	1188.2 ±328.8[a]	1106.2 ±307.3[a]	–	35 ±10% (when the body weight is incorrect)	35 (<60 years of age) 30 (<60 years of age)	35 30–35**	–
	% of compliance	50.67	47.17					
Protein g/kg IBW	average ±SD	49.06 ±16.10[a]	46.00 ±14.79[a]	–	1.2–1.4 (>50% of high biological value)	1.2 (>50% of high biological value)	1.0–1.2	–
	% of compliance	61.10	57.21					
Fats, %	average ±SD	39.51 ±13.04[a]	37.95 ±12.03[a]	20–35%	–	–	–	–
	% of compliance	75.83	72.84					
SFA, g	average ±SD	13.49 ±5.11[a]	13.43 ± 4.32[a]	<5–6%	–	–	–	–
	% of compliance	norm	norm					
Cholesterol, mg	average ±SD	162.92 ±97.12[a]	174.68 ±70.33[a]	N/A	–	–	–	–
	% of compliance	N/A	N/A					
Carbohydrates, g	average ±SD	171.77 ±47.21[b]	156.49 ±44.39[a]	45–65%	–	–	–	–
	% of compliance	65.11	59.32					
Simple sugars, g	average ±SD	20.83 ±10.79[a]	20.95 ±13.10[a]	<10%	–	–	–	–
	% of compliance	norm	norm					
Dietary fibre, g	average ±SD	14.09 ±4.39[b]	12.54 ±3.72[a]	25	–	–	–	–
	% of compliance	56.36	50.16					
Na, mg	average ±SD	1448.28 ±465.34[b]	1267.00 ±409.40[a]	–	1800–2500*	–	1800–2500	–
	% of compliance	80.46	70.39					
K, mg	average ±SD	1939.52 ±520.75[a]	1814.32 ±615.35[a]	–	2000–2500*	–	2000–2500*	–
	% of compliance	77.58	72.57					
Ca, mg	average ±SD	334.74 ±134.68[a]	317.10 ±139.22[a]	800–1000	–	–	–	–
	% of compliance	33.47	31.71					
P, mg	average ±SD	770.07 ±240.19[a]	721.38 ±223.63[a]	–	800–1000*	–	1000–1400*	–
	% of compliance	96.25	90.17					

Table 1 – cont.

1	2	3	4	5	6	7	8	9
Mg, mg	average ±SD	181.15 ±56.43^{a}	165.58 ±52.63^{a}	W: 265–320 M: 350–420	–	–	–	–
	% of compliance	49.77	45.49					
Fe, mg	average ±SD	6.68 ±1.96^{a}	6.27 ±1.70^{a}	W: 18; M: 10	–	–	–	W: 15; M: 8
	% of compliance	56.04	52.60					
Zn, mg	average ±SD	6.28 ±1.84^{a}	5.80 ±1.67^{a}	W: 6.8–8 M: 9.4–11	–	–	–	W: 8–12; M: 10–15
	% of compliance	47.15	43.54					
Vitamin								
A, ug	average ±SD	557.8 ±283.50^{a}	606.7 ±332.53^{a}	W: 500–700 M: 630–900	–	–	–	700–900
	% of compliance	61.98	67.41					
D, ug	average ±SD	2.21 ±1.60^{a}	2.31 ±1.57^{a}	15	–	–	–	–
	% of compliance	14.73	15.4					
E, IU	average ±SD	5.41 [mg] ±2.30^{b}	4.62 [mg] ±1.73^{a}	W: 12 (8 mg) M: 15 (10 mg)	–	–	–	400–800 (267–533 mg)
	% of compliance	1.02	0.87					
B_1, mg	average ±SD	0.75 ±0.23^{a}	0.68 ±0.24^{a}	W: 0.9–1.1 M: 1.1–1.3	–	–	–	1.1–1.2
	% of compliance	62.5	56.7					
B_2, mg	average ±SD	0.88 ±0.29^{a}	0.85 ±0.29^{a}	W: 0.9–1.1 M: 1.1–1.3	–	–	–	1.1–1.3
	% of compliance	67.69	65.38					
Niacin, mg	average ±SD	10.77 ±3.28^{a}	9.86 ±3.33^{a}	W: 11–14 M: 12–16	–	–	–	14–16
	% of compliance	67.31	61.63					
B_6, mg	average ±SD	1.23 ±0.37^{a}	1.14 ±0.38^{a}	W: 1.3–1.5 M: 1.4–1.7	–	–	–	10
	% of compliance	12.3	11.4					
Folates, ug	average ±SD	112.5 ±37.55^{a}	109.9 ±36.42^{a}	320–400	–	–	–	1000
	% of compliance	11.25	10.99					
B_{12}, mg	average ±SD	1.88 ±1.19^{a}	2.39 ±1.61^{a}	2.0–2.4	–	–	–	2.4
	% of compliance	78.33	99.58					
C, mg	average ±SD	26.31 ±10.99^{a}	26.97 ±11.89^{a}	W: 60–75 [67.5] M: 75–90 [82.5]	–	–	–	75–90
	% of compliance	29.23	29.97					

*The values can be variable depending on the individual reaction of the body.
**Elderly people and people with reduced physical activity.
W – women, M – men.
Values are expressed as mean ±SD. In the columns, means with different superscripts differ significantly ($p \leq 0.05$)

in relation to the recommended norms (Kalantar-Zadeh et al., 2011).

The fat and total carbohydrates contents were also reduced. The percentage of fat for energy supply in the diet was an average of 39.51% ±13.04 (I stage) and 37.95% ±12.03 (II stage), which is slightly above the recommendations (Table 1). However, the amount of fat in grams/day to norms was too low because dietary calorie was also too low (I stage: 75.83 %; II stage: 72.84%). The diet of people in both stages provided SFA (stage I: 13.49 g ±5.11; stage II: 13.43 ±4.32), MUFA (stage I: 15.87 g ±5.54; stage II: 14.89 g ±5.45), PUFA (stage I: 6.71 g ±2.63; stage II: 6.19 g ±2.27), and cholesterol (stage I: 162.92 mg ±97.12; stage II: 174.68 mg ±70.33). The amount of SFA, cholesterol and monosaccharides were correct at both stages of the study. Kardasz and Ostrowska say that the total amount of fat in female hemodialysis patients' diet was correct, and in men, the total amount of fat in the diet was exceeded relative to recommended norms (Kardasz and Ostrowska, 2012). According to Arslan et al. (2010), the diet of hemodialysis patients was rich in fats, and this diet was exceeding the recommended standards. The cholesterol supply was within the recommended range and was an average of <300 mg/day.

According to Kardasz and Ostrowska (2012), the carbohydrates supply in the diets of hemodialysis patients was well below recommended values, and for women it was 33.2–35.1% and for men: 44.9–50.1% of recommended standards. When there is too little carbohydrate in the diet, incomplete fat burning occurs and consequently, there is a build-up of ketones in the body, which then leads to acidosis, malnutrition, and serious complications. Sahin et al. (2009) indicate too low a proportion of carbohydrates in the diet of renal replacement patients.

Fiber consumption in the patients' diet was lowered. It was higher in the 1st stage of the study, which could have been caused by a greater availability of vegetables and fruit. The literature says that a proper supply of fiber for dialysis patients contributes to a reduction in chronic generalized inflammation, as well as a reduction in mortality among these patients (Chuć et al., 2018; Krishnamurthy et al., 2012).

The amounts of minerals in the diets of tested people was often below standard. In the diet of study participants in both of the study stages, there was the least Ca, Zn, and Mg. Fe, K, and Na were also below standard. A statistically significant difference in Na supply between the 1st and 2nd stage of research was also observed. K was also slightly below the norm, both in the 1st and 2nd stages of the study.

Vitamin supply in the diet was insufficient. Vitamin E was recorded as being the least, where a statistically significant difference was found in supply between both stages of the study; in the first stage, there was more vitamin E than in the second stage. Shortages were found for folates, vitamin B_6, and vitamin D. The vitamin D supply is very important, since a lack of metabolically active vitamin D, in combination with hyperphosphatemia, results in secondary hyperparathyroidism and a disease called *osteitis fibrosa cistica* (bone destruction) because of increased bone turnover (Zdrojewski, 2008). Moreover, there were shortages of vitamin C, A, B_1, B_2, niacin, and in the 1st stage vitamin B_{12}. The statistical analysis showed that, regardless of the testing period, there was no significant effect on the intake of vitamins such as vitamin A, D, B_1, B_2, B_6, B_{12}, C, folate, and niacin (Table 1). Low levels of vitamin B_{12} result from a reduction in the diet of products which are its rich source, and on the other hand hemodialysis contributes to the removal of vitamin B_{12} (Saifan et al., 2013).

Our obtained results of chosen vitamins and minerals supply with the diet confirms the statements of other authors about the necessity of water-soluble vitamin supplementation by dialysis patients Cano et al., 2006; Jankowska et al., 2014), and also supplementation of vitamin D, Zn, and S in the appropriate doses.

The study of morphological parameters in participants of our research showed normal values for the content of WBC, PLT (women and men) and normal content of HGB (women) (Table 2). Shortage values were observed for RBC and HCT in both genders. The similar results of HCT and the lowering content of RBC was observed in the Rutkowski et al. (2011) studies. In our research, the HGB content indicated that in comparison to the norm, it was lowered for men (respectively, at 7% and 6% for 1st and 2nd stage). In our study, in women, the values of HCT were reduced by 6% and 10%, respectively, for 1st and 2nd stage of research. Among men, the values of HCT were also reduced at 12% in the 1st stage and 14% in the 2nd stage of the study.

We observed an increased content of creatinine in women and men, and normal values for the amount of albumin; however, the latter was close to the lower limit of the norm, which indicates the necessity of a better dietary balance for patients and supplementing it with protein and energy (Table 2). In the research of

Table 2. Evaluation of the values of biochemical and morphological parameters of blood in hemodialysis patients in relation to recommended standards

Parameter	Indicators		Stage I	Stage II	Reference values range	
					women	men
RBC, mln/µl	average ±SD	women	3.49 ±0.56	3.46 ±0.45	3.5–5.0	4.5–6.5
		men	3.74 ±0.73	3.78 ±0.79		
		average	3.61 ±0.65[a]	3.61 ±0.64[a]		
	% of compliance	women	99.7	98.9		
		men	83.1	84.0		
HGB, g/dl	average ±SD	women	11.22 ±1.46	11.45 ±0.99	11–15 [100–136.4%]	12–17 [100–141.7%]
		men	11.22 ±1.54	11.68 ±1.79		
		average	11.22 ±1.47[a]	11.56 ±1.40[a]		
	% of compliance	women	102.0	104.1		
		men	93.5	96.3		
HCT, %	average ±SD	women	34.82 ±4.76	33.12 ±3.80	37–47	40–54
		men	35.33 ±5.05	34.50 ±5.67		
		average	35.06 ±4.83[b]	33.77 ±4.74[a]		
	% of compliance	women	94.1	89.5		
		men	88.3	86.3		
WBC, tys./µl	average ±SD	average	6.56 ±2.31[a]	6.64 ±2.29[a]	3.8–10.5 [100–276.3%]	
	% of compliance		172.6	174.7		
PLT, tys./µl	average ±SD	average	180.6 ±7.95[a]	192.9 ±58.60[b]	140–345 [100–246.4%]	
	% of compliance		129.0	137.8		
Albumin, g/l	average ±SD	average	40.40 ±2.78[a]	40.68 ±3.44[a]	35–52 [100–148.6%]	
	% of compliance		115.4	116.2		
Creatinine, mg/dl	average ±SD	women	6.07 ±1.16	6.75 ±1.31	0.5–0.9 [100–180%]	0.5–1.1 [100–220%]
		men	7.02 ±2.79	7.45 ±3.21		
		average	6.52 ±2.11[a]	7.08 ±2.38[b]		
	% of compliance	women	1214.0	1350.0		
		men	1404.0	1490.0		
TCHOL, mg/dl	average ±SD	average	172.2 ±42.36[a]	171.1 ±41.56[a]	<200	
	% of compliance		<200 NORM	<200 NORM		
TG, mg/dl	average ±SD	average	217.9 ±136.17[a]	216.9 ±104.4[a]	<150	
	% of compliance		145.3	144.6		
P, mmol/l	average ±SD	average	1.79 ±0.62[a]	1.82 ±0.60[a]	0.84–1.45 [100–172.6%]	
	% of compliance		213.1	216.7		

Values are expressed as mean ±SD. In the columns, means with different superscripts differ significantly ($p \leq 0.05$).

Rutkowski et al., the results were similar: the level of albumin was in the range of the norm, although it approached the lower limit of the norm (Rutkowski et al., 2011). The literature says that there are also situations when patients with CKD could have normal values of albumin, e.g., anorexic patients, without inflammation, or cachexia, where the level of the albumin in the serum is in the reference range (Kalantar-Zadeh et al., 2011). The level of albumin decreases when GFR is lowered, the values of creatinine deteriorates, and body mass is lowered (Kaysen, 2003), which suggests the necessity of controlling these parameters in hemodialysis patients.

In our research, the content of TCHOL in the blood was also normal (Table 2). However, TG in patients was increased. Both in the first and second stage, the values of TG exceeded acceptable standards, respectively, at 45% for the first stage and at 44% for the second stage. Increased values were also observed for the content of phosphorus (stage I: higher by 23%; stage II: higher by 26%). Rutkowski et al. (2011) observed, that hemodialysis patients have TCHOL normal and increased values of TG. The literature indicates that patients with end stage CKD often have lipid disorders, lowered values of HDL cholesterol, and also values of elevated levels of TG in the blood of patients (Longenecker et al., 2008).

Increased values of Na, K, and Ca weren't observed before or after hemodialysis. Only slight variations in the content of K were noted before hemodialysis in the 1st stage, and Ca after hemodialysis in the 2nd stage (Table 3).

However, greatly increased values of urea were noted before hemodialysis. In the first stage, values increased by 121% in comparison to the norm, and in the second stage by 173%. In both stages, hemodialysis equalized blood urea content to reference values.

In both stages, the average values of GFR were significantly decreased in every patient for the V stage of CKD. The average values of Kt/V index were normal (Table 3). In the other studies, the average dose of dialysis was on the level: 1.75 ±1.31 (Yustea et al., 2013) or was in the range: 1.3 ±0.2–1.4 ±0.2 (Rutkowski et al., 2011).

The correlation between protein consumption in the diet and the value of albumin in the serum have also been assessed. Analysis has shown that when protein consumption was higher, the amount of albumin

Table 3. Evaluation of selected blood biochemical parameters in hemodialysis patients before and after hemodialysis

Parameter	Indicators (before/after hemodialysis)		Stage I	Stage II	NORM
Na, mmol/l	average ±SD	before	135.0 ±2.26[aA]	134.8 ±2.57[aA]	135–145
		after	134.6 ±1.06[aA]	135.0 ±1.50[aA]	
K, mmol/l	average ±SD	before	5.08 ±0.61[bA]	4.94 ±0.44[bA]	3.6–5.0
		after	4.01 ±0.28[aA]	3.95 ±0.39[aA]	
Ca (ionized), mmol/l	average ±SD	before	1.07 ±0.08[aA]	1.06 ±0.09[aA]	0.98–1.13
		after	1.13 ±0.08[bA]	1.14 ±0.10[bA]	
Urea, mg/dl	average ±SD	before	110.7 ±28.27[bA]	136.3 ±36.25[bB]	12–50
		after	32.24 ±12.88[aA]	38.28 ±14.70[aB]	
GFR ml/min/1.73 m^2	average ±SD		8.63 ±3.98 (range 4.90–21.00 ml/min/1.73m^2)	7.98 ±3.91 (range 4.40–19.00 ml/min/1.73m^2)	≥90
Kt/V index	average ±SD		1.53 ±0.17 (range 1.27–1.90)	1.58 ±0.29 (range 0.71–2.08)	N/A

ab – significant difference before and after hemodialysis $p < 0.05$.
AB – significant difference between the first and the second stage $p < 0.05$.

in the serum increased. There was a statistically significant dependence ($R = 0.43$; $p < 0.05$). Sarwar and Sherman (2017) indicate a small positive correlation between protein consumption in the diet of patients with CKD. At the same time, they note the more important relevance present in these patients' group concerning albuminuria or inflammation, which determine the actual level of albumin in serum; this cannot be overlooked. However, Kaysen (2003) says that in people without inflammation, reduced protein and energy intake doesn't lead to a decrease in the albumin level in serum, which is conditional on natural processes that are responsible for the homeostasis of an organism. However, concurrent consumption of too little protein in combination with inflammation inhibits the natural defense process and this reduces levels of albumin, transferrin, prealbumin, and also muscle mass (Kaysen, 2003).

Moreover, in our study, the correlation between the content of vitamin B_{12} and blood morphology (amounts of RBC, HGB and HCT) was assessed. Statistical analysis says that a higher consumption of vitamin B_{12} correlates positively with increasing amounts of RBC ($R = 0.38$; $p < 0.05$), and also improves the value of HGB ($R = 0.47$; $p < 0.05$) and HCT ($R = 0.40$; $p < 0.05$).

SUMMARY

The results indicate the importance of implementing appropriate dietary recommendations and dietary intervention in order to improve the effectiveness of therapy and reduce mortality in hemodialysis patients. It also indicates the necessity of supplementation in many cases, in particular concerning ingredients for which demand is increasing significantly.

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