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## ASSESSMENT OF THE MUSCULAR STRENGTH OF THE GLOBAL HANDGRIP AND PHYSICAL ACTIVITY IN PATIENTS TREATED WITH RENAL REPLACEMENT THERAPY (RRT) BY HEMODIALYSIS

Agnieszka Turoń-Skrzypińska<sup>1</sup>, Damian Babkiewicz<sup>2</sup>, Ewa Nizio<sup>3</sup>,  
Radosław Boćkowski<sup>4</sup>, Katarzyna Pulwer<sup>5</sup>, Natalia Tomska<sup>6</sup>, Aleksandra Szylińska<sup>7</sup>,  
Aleksandra Rył<sup>8</sup>, Iwona Rotter<sup>9</sup>

1, 6, 7, 8, 9 Department of Medical Rehabilitation and Clinical Physiotherapy, Pomeranian Medical University, Żołnierska 54, 71-210, Szczecin, Poland.

2,3,4,5 Student Science Club “KINEZIS” at the Department of Medical Rehabilitation and Clinical Physiotherapy, Pomeranian Medical University, Żołnierska 54, 71-210, Szczecin, Poland.

**Key words :** Hemodialysis, physical activity, handgrip, muscular strength

### Abstract

#### Introduction

Chronic Kidney Disease (CKD) is a social problem. Hemodialysis is the most common method of renal replacement therapy. At the beginning of hemodialysis treatment, physical activity is reduced by 50-60%. The aim of the study was to compare physical activity, handgrip strength and selected anthropometric parameters, and to assess the relationship between handgrip strength, selected anthropometric parameters and the level of physical activity.

#### Material and methods

The study included 30 patients aged  $65.92 \pm 14.65$  treated by hemodialysis. The study consisted of patients completing a proprietary survey questionnaire, assessing physical activity using the International Physical Activity Questionnaire (IPAQ), handgrip strength,

<sup>1</sup> Agnieszka Turoń-Skrzypińska, ORCID: 0000-0002-4140-4656 55

<sup>2</sup> Damian Babkiewicz, N/A

<sup>3</sup> Ewa Nizio, N/A

<sup>4</sup> Radosław Boćkowski, N/A

<sup>5</sup> Katarzyna Pulwer, N/A

<sup>6</sup> Corresponding author: Natalia Tomska, Pomeranian Medical University in Szczecin, Department of Medical Rehabilitation and Clinical Physiotherapy, Pomeranian Medical University, Żołnierska 54, 71-210, Szczecin, Poland, e-mail: natalia.tomska@o2.pl, ORCID: 0000-0002-9604-9938

<sup>7</sup> Aleksandra Szylińska, ORCID: 0000-0001-6105-5329

<sup>8</sup> Aleksandra Rył, ORCID: 0000-0002-5954-4489

<sup>9</sup> Iwona Rotter, ORCID: 0000-0002-4337-6476

and performing selected anthropometric measurements. The examinations were performed at baseline (E0) and after three months of hemodialysis (E3) treatment and the results were compared.

### **Results**

There were no significant differences in the study group for physical activity and global handgrip strength at baseline and after three months of the study. There was no statistically significant differences between physical activity and handgrip strength in study and control group.

### **Conclusions**

Patients treated with renal replacement present less physical activity compared to people with normal kidney function. The BMI value and level of physical activity does not affect the handgrip strength in hemodialysis patients.

## **Introduction**

Chronic Kidney Disease (CKD) is a serious social problem. In the world suffer from it about 600 million people, including 4.3 million in Poland (Kubasiak et al,2017). The incidence of chronic kidney disease has increased in the last decade by about 20-25% (Linden et al.2010). Hemodialysis is the most common method of renal replacement therapy. Patients spend on hemodialysis treatment several hours a week (Wojtczyk,2014). In Poland, in 2016, 5,716 patients started renal replacement therapy. By the end of 2016, 20,144 patients were dialyzed, this is a slight decrease in the number of patients compared to 2014 and 2015 (Raport,2016). It has been shown that people starting dialysis, reduce their physical activity to 50-60% of normal. As a result of renal replacement therapy by hemodialysis, the level of protein destruction (PEW) increases, it reflects on a decrease in handgrip strength, and as a result there is a decreasing in muscle mass of patients (Wojtczyk,2014). Hemodialysis patients often show signs of malnutrition as evidenced by the decrease in anthropometric parameters such as waist and hips (Małgorzewicz et al.2013). The aim of the study was to compare physical activity measured with the International Physical Activity Questionnaire (IPAQ) and the strength of the global handgrip and selected anthropometric parameters at the time of entering to the study and after 3 months of the research project duration. An additional goal was to assess the relationship between physical activity and global handgrip as well as the value of selected anthropometric measurements.

## **Material and methods**

The study included 30 patients aged  $65.92 \pm 14.65$  with end-stage renal disease treated by hemodialysis. Participants of the study group were included in the hemodialysis program (HD) for at least three months with a frequency of three times a week (the duration of a single hemodialysis session was on average  $242.6 \pm 25.2$  and the duration of renal replacement therapy  $56.0 \pm 7.0$ ). The control group consisted of 30 patients without kidney disease with GFR over 60 ml / min / 1.73m<sup>2</sup> at the age of  $65.93 \pm 14.22$  recruited from the general population in Szczecin reporting for check-ups to a family medicine specialization doctor. The research was conducted from November 2018 to March 2019.

The study consisted the author's questionnaire prepared for the purposes of the study, which contained metric questions and enabled the collection of data on: the health status and lifestyle of the study participant. The assessment of physical activity was made using the standardized International Physical Activity Questionnaire IPAQ (Polish version developed in 2004 by Elżbieta Biernat and Romuald Stupnicki). The questionnaire contained 7 questions

about the type of performed physical activity (activities performed at work, at home, in free time, and moving between different places). The questionnaire examined the intensity of the effort and determined its MET value - Metabolic Equivalent of Work (low intensity effort: 3.3 MET; moderate: 4.0 MET; high: 8.0 MET). The results of calculation (according to the methodology of procedure IPAQ) of the total physical activity tested were classified into a suitable (high, moderate, or low) a physical activity, according to prescribed criteria by the KN IPAQ. Patient achieved high intensity by performing 3 or more days of intense physical activity (total at least 1500 MET-minutes / week) or 7 or more days of any combination of different types of physical activity exceeding 3000 MET - minutes / week; Moderate - patients perform 3 or more days of intense physical activity, not less than 20 minutes/day, 5 or more days of moderate exercise or walked no less than 30 minutes/day or 5 or more days of any combination of different types of exercises exceeding 600 MET - minutes / week; low when patient was completely inactive (below 600 MET - minutes / week).

The global handgrip strength of the non-dominant hand, without a fistula, was measured using a Charder MG-4800 dynamometer and selected anthropometric measurements (body weight, body height, waist circumference, hip circumference, left and right arm circumferences of the upper limbs) three times, and the average of these measurements was taken for analysis. Measurements were taken on the beginning of the examination (E0) and after three months (E3). In the study group, measurements were taken 20-30 minutes after hemodialysis at the Department of Nephrology, Transplantology and Internal Diseases of the Pomeranian Medical University in Szczecin, in a prepared examination room. Anthropometric measurements were carried out in accordance with applicable guidelines, in the examined persons dressed in underwear, without footwear.

Before re-examination, three patients had a kidney transplant and 5 died. Finally, 22 patients participated in the E3 examination. The characteristics of the study and control groups are presented in tables 1 and 2.

Bioethics Commission acting at the Pomeranian Medical University in Szczecin has expressed a positive opinion to conduct a research project (KB-0012/40/13).

Table 1

Basic characteristics of the study group and control group in terms of sex, age, height, dry body weight, BMI, waist circumference, hip circumference, duration of a single hemodialysis

Parameter		<b>B</b> (n=30)	<b>K</b> (n=30)	<b>P-value</b>
<b>Gender</b>	Woman	17 (56.67%)	15 (50.0%)	0.605 <sup>1</sup>
	Man	13 (43.33%)	15 (50.0%)	
<b>Age [year]</b>	AM	67.97	63.87	0.830 <sup>2</sup>
	SD	13.21	15.92	
	Me	69.0	67.0	
<b>Height [m]</b>	AM	1.67	1.68	0.976 <sup>2</sup>
	SD	0.11	0.09	
	Me	1.66	1.65	
<b>Dry body weight [kg]</b>	AM	74.72	75.67	0.994 <sup>2</sup>
	SD	15.48	14.77	
	Med	75.0	75.0	
<b>BMI [kg/m<sup>2</sup>]</b>	AM	27.01	26.87	0.620 <sup>2</sup>
	SD	4.46	4.19	
	Med	26.92	25.81	
<b>Waist circumference [cm]</b>	AM	93.69	93.4	0.862 <sup>2</sup> 0.055 <sup>2</sup>
	SD	18.18	14.01	
	Me	90.0	92.5	
<b>Hip circumference [cm]</b>	AM	100.55	106.33	
	SD	19.63	8.9	
	Me	99	105.5	

<sup>1</sup>Chi-kwadrat; <sup>2</sup>U Mann-Whitney;

**B** - study group; **K** - control group; **BMI** - body mass index; **cm** - centimeter; **m** - meter; **kg** - kilogram;

**AM** - arithmetic average; **SD** - standard deviation; **Me** - Median; **p-value** - statistical significance.

There were no statistically significant differences in gender, age, height, weight, BMI, waist circumference and hip circumference due to the study group and control group.

Table 2

Comparative characteristics of the study group and the control group in terms of comorbidities and habitual behavior.

	<b>B</b> (n=30)	<b>K</b> (n=30)	<b>P-value</b>
<b>Diabetes</b>	11(36.67%)	1 (3.85%)	0.008 <sup>1</sup>
<b>Hypertension</b>	19 (63.33%)	7 (24.14%)	0.005 <sup>1</sup>
<b>Smoking currently</b>	2 (6.67%)	4 (13.79%)	0.635 <sup>1</sup>
<b>Smoking in the past</b>	10 (33.33%)	12 (41.38%)	0.523 <sup>1</sup>

<sup>1</sup>Chi-kwadrat

**B** - study group; **K** - control group; **p-value** - statistical significance.

The groups differed in terms of the comorbidities presence. There were no statistically significant differences in the habitual behavior. Statistical analysis was performed using the statistical program STATISTICA 13.0. and an Excel spreadsheet.

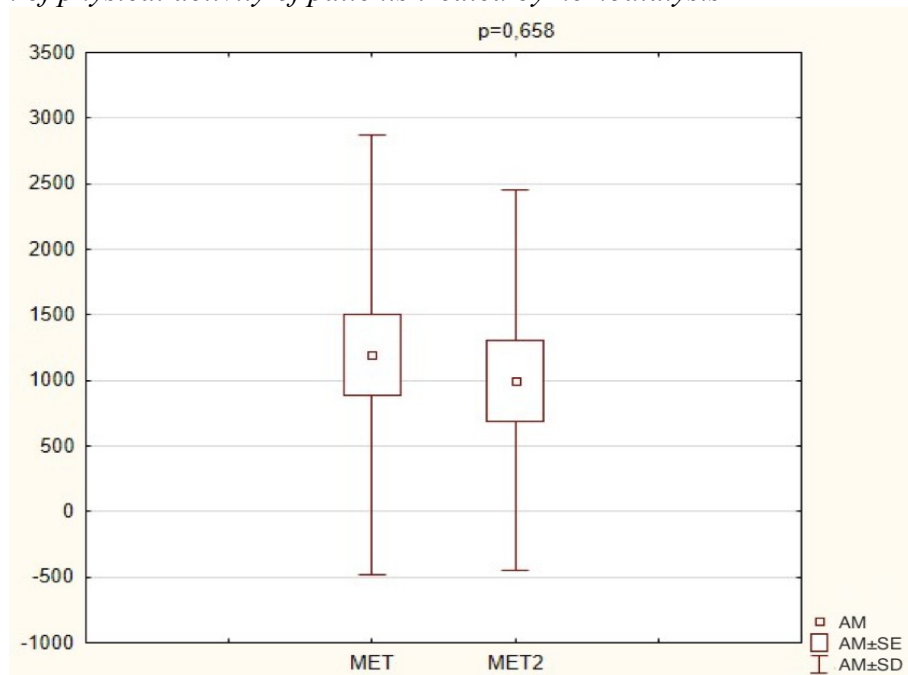
The significance of differences between the two groups was tested by the significance tests of Mann-Whitney and t-student test for independent samples. For checking the statistical significance of changes at the time of the E0 examination and the E3 examination, the Wilcoxon and T-Student Pair Order Test was used for dependent samples. The chi-square test was used to test the compatibility of the trait. Correlations were performed using Spearmann rank correlation. In all calculations, the level of significance was  $p \leq 0.05$ .

## Results

Comparison of physical activity in the study group is shown in Figure 1.

Figure 1

Comparison of physical activity of patients treated by hemodialysis

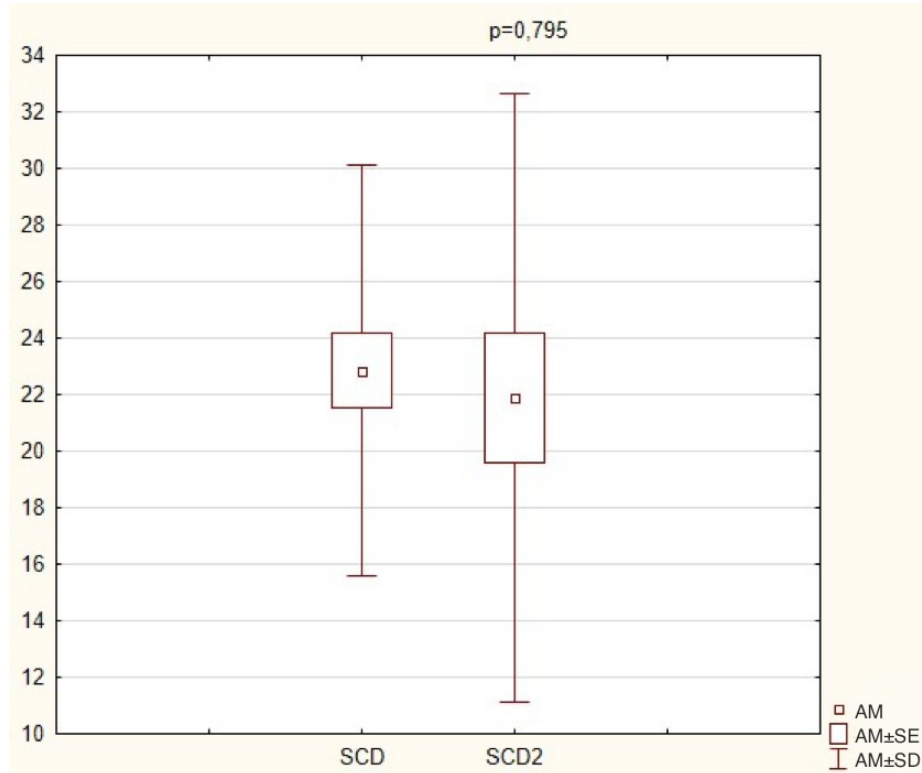


Statistical analysis revealed no significant changes ( $p=0.058$ ) between physical activity hemodialysis patients at the time of the study E0 (MET) and after 3 months of E3 (MET2).

Figure 2 shows a comparison of the dominant handgrip strength at the time of entering to the study and after three months of the research project duration.

*Figure 2*

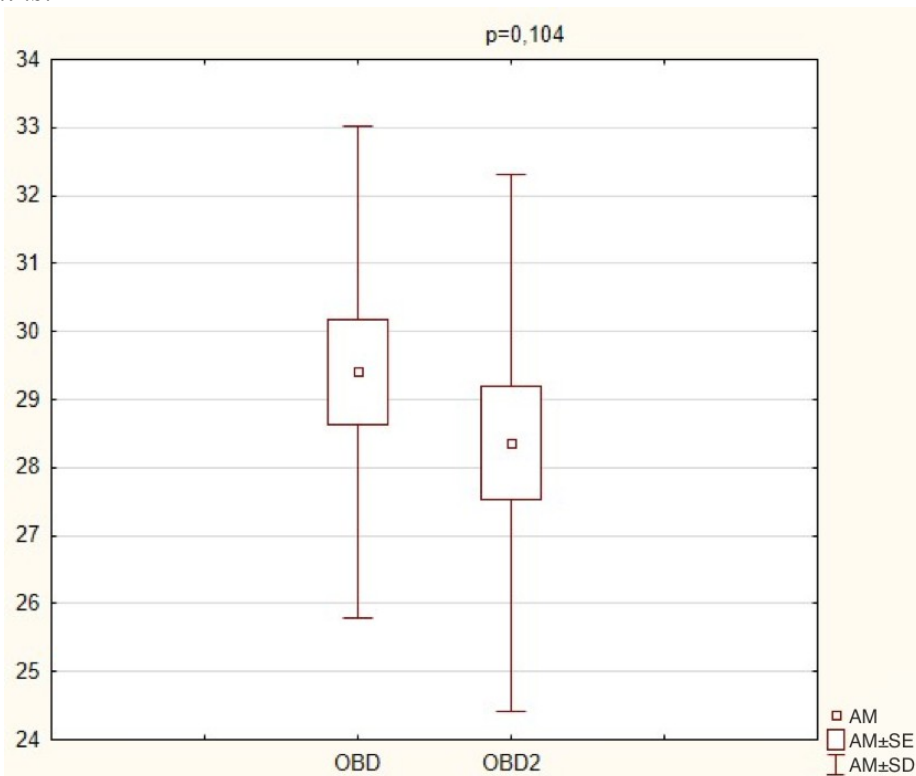
*Comparison of the global handgrip of the dominant hand during the first E0 examination and after three months E3.*



There were no statistically significant differences for the dominant handgrip strength during the E0 (SCD) examination and the E3 (SCD2) examination after 3 months of hemodialysis, achieving a significance of  $p = 0.795$ . Figures 3 and 4 present a comparison of the circumferences of the dominant hand in two attempts and the non-dominant hand also in two attempts.

Figure 3

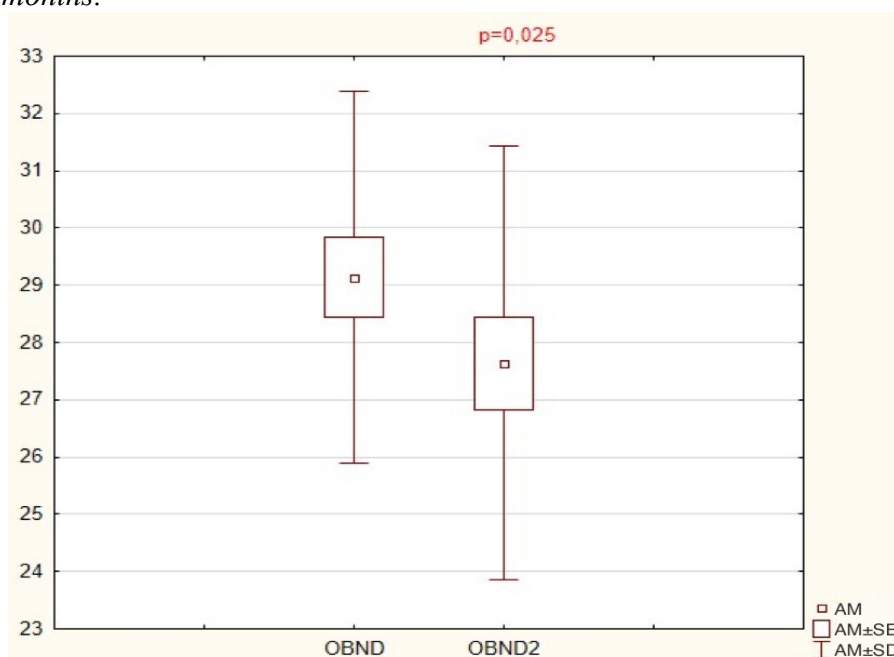
Comparison of arm circumference dominant hand at the moment of the first examination and after 3 months.



Comparison of the arm circumference of the dominant hand at the time of the first examination (OBD) and after 3 months (OBD2) did not show statistically significant differences reaching the level of significance  $p=0.104$ .

Figure 4

Comparison of the arm circumference non-dominant hand at the time of the first examination and after 3 months.



A statistically significant difference was found between the circumference of the non-dominant hand at the time of the first examination (OBND) and the circumference of the non-dominant hand after 3 months (OBND2)  $p = 0.025$ .

*Table 1*

*Comparison of the strength of the global handgrip (SCD, SCD2), the shoulder circuits of the dominant hand (OBD, OBD2) and non-dominant (OBND, OBND2) and physical activity (MET, MET2) between the study group and control group.*

	Study group (n=30)			Control group (n=30)			p
	AM	Me	SD	AM	Me	SD	
SCD	22.84	22.05	7.27	28.01	29.50	6.48	0.005*
SCD2	21.86	21.55	10.76	28.01	29.35	6.42	0.036*
OBD	29.52	30,00	3.82	30.03	31.00	3.79	0.605
OBD2	28.36	28.00	3.93	30.47	31.00	3.71	0.055
OBND	29.10	30.00	3.51	30.00	31.00	3.44	0.326
OBND2	27.64	27.00	3.79	30.02	31.00	3.50	0.023
MET	1195.08	673.20	1674.18	3180.73	2206.05	3623.65	0.002*
MET 2	1001.16	662.50	1448.03	3227.27	2267.50	3584.65	<0.001*

SCD - the strength of the global dominant handgrip in the E0 examination; SCD2 - the strength of the global dominant handgrip in the E3 examination; OBD - dominant hand circumference in the E0 examination; OBD2 - dominant hand circumference in the E3 examination; OBND - non-dominant hand circumference in the E0 examination; OBND2 - non-dominant hand circumference in the E0 examination; MET - level of physical activity according to the IPAQ scale in the E0 study; MET2 - level of physical activity according to the IPAQ scale in study E3

In the assessment of the measurement of the global handgrip strength at the time of the E0 examination, it was 22.84 kg in the study group and 28.01 kg in the control group. The differences are statistically significant ( $p = 0.005$ ). After three months (E3) in the study group decreased to 21.86 kg, and in the control group it remained unchanged ( $p = 0.036$ ).

Hemodialysis patients had significantly less global hand gripping strength. Statistical significance was also demonstrated in the measurement of physical activity between the groups in both the E0 ( $p = 0.002$ ) and E3 ( $p < 0.001$ ) examinations. In the E0 MET examination, the study group averaged 1115.08 min / week and the control group was 3180.73 min / week. During the E3 MET examination it was even smaller, as it was 1001.16 min / week in the study group and in the control group it increased to 3227.27 min / week. This indicates that the level of physical activity in hemodialysis patients is lower than the control group and the difference with the duration of renal replacement therapy is becoming greater. There were no statistically significant differences between circuits of the dominant upper limbs in both groups. A statistically significant difference occurred in the measurement of the non-dominant upper limb circumference in examination E3. In the study group averaged in a 27,64cm, and in control group 30,02cm. E0 examination showed no such significance. The circumference of the limbs on which patients have a fistula became along with study time significantly smaller compared to the control group.



*Table 2*  
*Correlation between selected parameters in the study group*

Correlation	R	p
SCD & MET	0.024	0.900
SCD2 & MET2	-0.034	0.881
SCD & OBD	0.098	0.612
SCD2 & OBD2	0.062	0.785
SCD & BMI	0.156	0.410
SCD2 & BMI2	0.207	0.355

SCD - the strength of the global dominant handgrip in the E0 examination; SCD2 - the strength of the global dominant handgrip in the E3 examination; OBD - dominant hand circumference in the E0 examination; OBD2 - dominant hand circumference in the E3 examination; MET - level of physical activity according to the IPAQ scale in the E0 examination; MET2 - level of physical activity according to the IPAQ scale in E3 examination; BMI - Body Mass Index in E0 examination, BMI2 - Body Mass Index in E3 examination.

Table 2 shows the correlation between the strength of the global handgrip and the other tested parameters. There was no significant correlation between the level of physical activity and the strength of the global handgrip in E0 or E3 examination. There was also no significant correlation between the strength of the global handgrip and its circumference. This correlation did not change significantly from the duration of renal replacement therapy, because in examination E0 and E3 the correlation did not change. The strength of the global handgrip did not correlate with BMI either, because no significance was demonstrated between these parameters in both examination E0 and E3.

## **Discussion**

There are many publications confirming the positive effect of physical activity on the body. Regular physical activity is a key element in the prevention of chronic diseases such as CKD. Although regular physical activity is currently recommended for patients undergoing hemodialysis, it is still significantly lower compared to the healthy population (WHO 2013, Warburton et al.2006, Heiwe and Jacobson 2011, Hornik et al. 2017, Johansen and Painter 2009, Lee et al. 2012).

Deterioration of health and renal replacement therapy makes that hemodialysis patients have difficulty in exercising. In this group of patients physiological effects of lack of movement can be observed, such as: decrease in physical efficiency of the body, degenerative changes in muscles and bones, including an increased risk of fractures in relation to peers. Reduced physical activity is affected by acute and chronic complications resulting from the treatment used. Other causes of reduced activity include uremic atrophy and skeletal muscle dysfunction as well as anemia (Castaneda et al. 2004, Arem et al. 2015, Block at al. 2004, Kalantar-Zadeh et al.2006).

In studies conducted by Tawney et al. (2000) which assessing the impact of physical activity for improving physical function 82 patients with end-stage renal disease in the fifth stage. Patients were divided into two groups.

The first group was included in a 6-month rehabilitation program that was added to standard clinical management. In the second group only standard clinical management was conducted. The study showed that six months of physical activity had a positive effect on the daily functioning of this group of patients. In addition, the control group reported

deterioration of health after 6 months. In this study, the time between studies was 3 months, which is the reason why there is no significant difference in the context of physical activity (Tawney et al. 2000).

Similarly, research conducted by Kouidi et al. in the group of 35 hemodialysis patients aged  $48.8 \pm 13.9$  included 10 months of training on days without hemodialysis. Was performed on a treadmill exercise test combined with spirometry and depression and quality of life tests. The measurement were done before training and after 10 months. These studies also demonstrate the positive effect of physical exercise conducted at improving the overall efficiency of the organism ( $Vo_{2peak}$  was increased by 21.1% and exercise time by 23.6%) (Ouzouni et al 2009).

Nowicki et al Presented reports in which they showed that spontaneous physical activity of patients treated by hemodialysis increased after using a pedometer as a motivating tool for exercise. Autors of the study examined 33 patients undergoing hemodialysis at the age of 58-65 years. The total number of steps recorded between 2 dialysis sessions in the middle of the week increased from  $9.337 \pm 5.317$  to  $11.921 \pm 5.909$ . The solution proposed by Nowicki can be a way to increase the physical activity of hemodialysis patients and reduce the negative effects of hemodialysis (Nowicki et al 2010).

No significant differences in the decrease in physical activity of hemodialysis patients were found in these studies after 3 months. It can also be seen that the average activity in both cases remains at the level of 1000-1200 MET. The interpretation of the used tool defines the above result as sufficient physical activity. This range is from 600 to 3000MET (Biernat et al.2007).

Contrary to the own research, Kubasiak et al. by examining hemodialysis patients showed that with decreasing physical activity the gripping strength of the dominant hand decreases. 59 subjects treated by hemodialysis (mean age  $57.77 \pm 15.70$ ) were examined and divided by physical activity of the arteriovenous fistula hand. In all patients the fistula was on the non-dominant hand.

In a study conducted by Nasser and co-authors presented a correlation between global handgrip strength, and malnutrition in hemodialysis patients. Renal replacement therapy by hemodialysis may result in cardiovascular malnutrition due to reduced food intake, anorexia or frequent vomiting. In these studies, the level of patient malnutrition was examined using the MIS scale (the author's own method consisting of the SGA method and other markers such as serum albumin and body mass index). 83 hemodialysis patients from a selected dialysis station in Iran were examined. The study was performed using a dynamometer in accordance with the recommendations of the American Society of Hand Therapists. It was shown that muscle strength was greater in subjects with mild malnutrition than in patients with moderate malnutrition. In addition, no statistical significance was demonstrated for handgrip strength and BMI, as well as for handgrip strength and age (Naser et al. 2016). This study also showed no relationship between global gripping strength and BMI value.

Studies by Garagarz et al. showed a relationship between the strength of global handgrip and lean mass mass in dialysis patients, in which 155 patients treated with hemodialysis for more than 3 months aged 64-70 took part. A positive correlation between handgrip strength and lean body mass was demonstrated. However, a negative correlation was shown between the global gripping strength and BMI. Similar relationships are presented in this study after 3 months of hemodialysis (Garagarza et al. 2018).

Chan et al. Conducted randomized studies in a group of 60 patients on hemodialysis aged over 55-85 years. Researches on physical activity and global handgrip strength were performed in the United States. Subjects were randomly assigned to a 12 week training plan or to care without physical activity. Patients were evaluated for  $VO_{2max}$  using a 6-minute walk test and global handgrip with a dynamometer. Prior to study initiation, patients had

reduced maximal aerobic effort and muscular strength. Results of the test shows that patients performing physical training for 12 weeks obtained better values for VO<sub>2</sub> max and increased muscle mass than non-training patients (Chan et al.2019). No physical training was used in these studies, therefore, 3 months of hemodialysis did not significantly change the strength of the global handgrip.

Jeznach-Steinhagen et al. Conducted a study on 53 dialysis patients divided into two groups by nutrition level. Anthropometric measurements such as arm circumference, waist circumference, hip circumference, body weight, height, BMI and skin fold thickness above the lower edge of the scapula were used. The first group were malnourished people. The second group consisted of patients without signs of malnutrition. In the first group, researchers found significantly lower values of anthropometric nutrition indexes. The assessment of selected anthropometric indicators enables the assessment of the malnutrition level of a hemodialysis patient. The studies showed no statistically significant differences for the right shoulder circumference and hip circumference. Presents statistically significant differences in the left arm circuit. In the submitted work, anthropometric measurements were to check whether hemodialysis causes the destruction of the body visible at the level of these measurements (Jeznach-Steinhagen et al. 2013).

Anthropometric measurements are widely used in clinical and epidemiological studies and primary and specialized medical care. Anthropometric measurements are an important element in the assessment of clinical and nutritional status. Thanks to them, the risk of death in hemodialysis patients can also be assessed. The most frequently used measurements are listed in the study Jeznach-Steinhagen: arm circumference, waist circumference, hip circumference, weight, height, BMI, and the thickness of the skin fold above the lower edge of the scapula (Jeznach-Steinhagen et al. 2013).

The body's nutritional status is measured using a BMI indicator. Body Mass Index calculates the appropriate amount of body weight per square meter. The results of these measurements were divided into three groups by the World Health Organization (WHO): the correct value of the indicator is 18.5-24.9 kg / m<sup>2</sup>, below 18.5 a person is in a malnourished condition, we are talking about excess weight when the BMI range is between 25-29.9 kg / m<sup>2</sup>, BMI over 30 kg / m<sup>2</sup> is already evidence of obesity (Brończyk-Puzoń et al.2008).

In patients on hemodialysis it is difficult to analyze the BMI indicator because it is easy to disturb the results by overhydrating the body. BMI is more reliable when used to calculate the dry weight of hemodialysis patients (Brończyk-Puzoń et al. 2008, WHO 1998, Rotham et al. 2008). In the presented work, analyzing selected anthropometric parameters in relation to the considered groups, there were no statistically significant differences in body weight, waist circumferences and BMI values at the initial level, after 3 months. The only statistical significance was demonstrated for arm circumferences non-dominant upper limb in the study group. After 3 months, this arm had a smaller circumference. These changes may be the result of exhaustion associated with the occurrence of a chronic disease, the use of an incorrect diet, digestive disorders and complications associated with renal replacement therapy. Hemodialysis and chronic kidney disease negatively affect muscle function and muscle mass. These factors are used to assess the clinical status of hemodialysis patients and nutritional status. Reduced muscle mass and muscle dysfunction are an unsatisfactory predictor of the results of hemodialysis treatment (Carrero et al.2013).

## **Conclusions**

Hemodialysis patients show less global handgrip strength and physical activity relative to people of similar age with normal renal function. Arm circumference, BMI, and physical activity levels do not affect on the global handgrip strength of hemodialysis patients.

## Limitations

The limitations of this study that could affect on the results of the study were the size of the study group. In continuation, of the group should be broadened in order to better analyze the results. The group during the study decreased by independent events such as deaths or kidney transplantation.

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