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Physical activity after kidney transplantation

ABSTRACT

Chronic kidney disease is a risk factor of cardiovascular mortality. Renal transplantation is the best treatment for end-stage renal disease. In renal transplant recipients, healthy lifestyle and physical activity are recommended to improve overall morbidity and cardiovascular outcomes. Combined moderate/vigorous physical exercise

appears to have a positive effect on major parameters related to cardiovascular risk factors, graft function, quality of life, and physical performance. Return to high-level sports after transplantation is also possible.

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Resting human heart pumps about 5 liters of blood within a minute; in the same time, about 22% of this quantity, or about 1 liter, flows through the kidneys. Upon maximum physical effort, the cardiac output of a healthy, even untrained, person is increased to 25 liters whereas the renal flow is reduced to 1% of this value, i.e. 250 mL. This had given rise to a long-standing belief that physical activity should be reduced in order to extend renal function. Along with the progression of chronic kidney disease (CKD), reduction in glomerular filtration rate, and retention of uremic toxins, patients experience a stronger sense of the disease and spontaneously reduce their physical activity. Uremic toxins — particularly aromatic amino acid derivatives — uncouple oxidative phosphorylation and thus reduce the aerobic effort capacity.

The above applies to end-stage renal failure. On the other hand, we know [1] that proper physical activity, namely a combination of aerobic and resistance exercise in earlier CKD stages:

1. does not accelerate the loss of the glomerular filtration;
2. does not increase proteinuria;
3. reduces in systolic and diastolic blood pressure;
4. improves the lipid profile;
5. increases maximum oxygen consumption (aerobic capacity parameter);
6. increases muscle strength;
7. leads to reduced body weight and BMI values.

Implementation or intensification of physical activity in elderly patients (by an additional 30 minutes per day) has a positive effect on their kidney function [2].

Recommendations for the physical activity in CKD patients are not different from those in the general population:

1. At least 150 minutes of moderate (non-occupational) physical activity or 75 minutes of intense activity per week;
2. Additional health benefits can be achieved by doubling the basic recommended activity, to 300 minutes of moderate or 150 minutes of intense activity per week.

Daily workouts including aerobic (cardio) and resistance exercises are preferred, e.g. aerobic workout 5 times a week and resistance workout 2 times a week (not on consecutive days) [3]. An example FITT Activity Program is presented in Table 1.

Maximum heart rate is 220 minus age in years, or $220 - 50 = 170$ bpm for a 50-year old subject (this is the target value in cardiac stress test):

- moderate intensity (aerobic) workout: 50–69% of maximum heart rate;
- high intensity (aerobic) workout: 70–90% of maximum heart rate.

The intensity of the aerobic exercise is expressed in MET (metabolic equivalent of task) units, where 1 MET corresponds to oxygen intake of 3,5 mL/min/kg. Moderate activity is defined as < 6 MET whereas intense activity is defined as ≥ 6 MET.

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Table 1. Example FITT aerobic and resistance workout program

	Aerobic exercise (Cardio)	Resistance exercise (Strength)
F (requency) How often	5 days per week for moderate intensity workout 3 days per week for high intensity workout 6–7 days per week for weight loss	2–3 days per week, but not on comorbidities days
I (ntensity) How much	Exercise at target heart rate Variable intensity	8–10 different exercises 1–3 series 8–16 repetitions in a series
T (ime) How long	30–60 minutes in a series Shorter for high-intensity training Once a week for 90–120 minutes	Up to 60 minutes for all-body activity Shorter for smaller muscle groups
T (ype) How	Any activity which significantly accelerates the subject's heart rate: running, walking, cycling, rollerblading, dancing	Resistance exercise: body mass, weights, expanders, machines

Examples of physical activities and their corresponding MET scores [4]:

- walking 2–3 km/h — 2.5 MET;
- cycling (recreational) — 4.0 MET;
- marching 5–6 km/h — 4.1 MET;
- gardening — 4.3 MET;
- swimming (recreational) — 4.5 MET;
- golf — 4.9 MET;
- climbing stairs — 6.0 MET;
- tennis — 7.5 MET;
- dancing — 7.5 MET;
- cycling (uphill) — 8.5 MET;
- swimming (sporting) — 9.0 MET;
- running 10 km/h — 10.0 MET;
- running 12 km/h — 12.0 MET.

Thus, the recommended physical effort for CKD patients is at least 450 MET-minutes/week, with 900 MET-minutes/week being associated with additional health benefits.

Appropriate physical activity combined with an appropriate diet facilitates the maintenance of [5, 6]:

- due body weight;
- proper body composition;
- muscle mass and strength;
- aerobic capacity;
- well-being.

The prolonged dialysis therapy while awaiting kidney transplantation not only degrades the physical fitness of dialyzed patients, but also lead to progressive cachexia or metabolic syndrome.

According to the American Heart Association (AHA), at least three of the following five criteria must be met for the diagnosis of the metabolic syndrome [7]:

- waist circumference of > 88 cm for women and > 102 cm for men;
- fasting blood glucose of > 100 mg/dL;
- systolic blood pressure of > 130 mm Hg and/or diastolic blood pressure of > 85 Hg

or appropriately controlled hypertension (values should be correct!);

- HDL cholesterol at < 50 mg/dL for women and < 40 mg/dL for men;
- triglycerides at >150 mg/dL or pharmacological treatment due to hypertriglyceridemia.

Anthropometric criteria of the International Diabetes Federation (IDF) are somewhat stricter and define the upper limits of waist circumference at 80 cm for women and 90 cm for men within the European population.

Autosomal dominant polycystic kidney disease (ADPKD) invalidates waist circumference as the diagnostic criterion of metabolic syndrome both before and after kidney transplantation.

The prevalence of metabolic syndrome in patients awaiting a kidney transplant ranges from 35 to 56%. About 80% of patients with transplanted kidney gain about 5 to 8 kg of body weight within one year and 8 to 15 kg of body weight within three years after transplantation [8].

The prevalence of the individual components of the metabolic syndrome in renal transplanted patients varies, yet an increase is observed within the first 2 to 3 years after transplantation to the following values (as measured 3years after transplantation) [9]:

- abnormal waist circumference — 41–70%;
- abnormal fasting blood glucose — 13–38%;
- hypertension — 36–82%;
- low HDL cholesterol levels — 40–52%;
- hypertriglyceridemia — 50–69%.

Therefore, appropriate pro-health policies including diet and physical activity should be implemented as early as possible. “As early as possible” means as early as on the first day after transplantation, provided that the proce-

ture was successful and uncomplicated. The following path for return to post-transplantation physical activity may be proposed to motivated, previously active individuals:

- after 6 hours — respiratory and “start-up” exercise
- first 3 weeks — limited workout, no press-type exercises
- after 3 weeks — workout at 30% of full capacity
- after 6 weeks — workout at 60% of full capacity (no jumps!)
- after 8–12 weeks — full workout

Full workout has been presented in Table 1. Individuals with sporting ambitions may start their specialized training 8 weeks after transplantation if permitted by their “transplant status” and particularly their graft function.

Guidebooks for renal transplant recipients encourage patients to take up regular physical activity, pointing to the following 5 benefits [10]:

- more energy;
- stronger muscles and bones;
- better fitness;
- maintained body weight;
- longer life expectancy.

Patients should avoid [10]:

- contact sports with the risk of injury to the transplanted kidney (not always complied with by professionals as they would have to change the discipline);
- dehydration (isosthenuric urine).

Appropriate, adequately rationed physical activity is becoming a regular element of the management of patients after kidney transplants [11, 12]. Sports, i.e. physical activity involving an element of competition, significantly improves the quality of life results [13]. Properly managed participants in cycling marathons are better in controlling their hydration than their competitors without kidney transplants [14].

The following are three very spectacular examples of professional athletes who managed to return to their full physical following preemptive kidney transplantations.

The first example is that of Aries Merritt — an American 110m hurdling champion who had broken the world record (12.80 s) in 2012 and won an Olympic Champion title during the London games in 2012 (12.92 s), as well as a bronze medal during the world championship in Beijing in 2015 (13.04 s) — at that time, his eGFR was about 20 mL/min/1.73 m². Having won the medal in Beijing on Friday, Merritt had a kidney transplant surgery (his sister being the donor) in Chicago on the following Tuesday. He missed the Rio Olympic Games (2016) because of coming up fourth in national run-offs (13.22 s). In 2017, during the World Championship in London, he finished fifth with the time of 13.31 s; six years earlier, in Daegu, he had also taken the fifth place with the result of 13.67 s [15]. The Polish record is 13.26s.

The second example is that of Ivan Klasnic, a Croatian football player with Werder Bremen, whose goal scored a year after double kidney transplantation (from his mother and then from his father) eliminated the Polish team from Euro 2008. In 2021, Klasnic received an EUR 4 million worth of compensation for his renal disease having been diagnosed too late by the Werder Bremen doctors [16].

The third example is that of Alonzo Mourning, an American basketball player who won the NBA championship while playing with a transplanted kidney and who has since lent his face to promote the successes of nephrology and transplantology e.g. during the American Society of Nephrology Congress. His earnings from basketball and promotional activities after the transplantation were 5 times higher than before procedure [17].

After the end of their active careers, all three gentlemen remained active in amateur sports. At the age of 36 years, Aries Merritt covers the 110 m hurdling distance in less than 15 seconds.

An example of a Polish amateur athlete with significant sporting achievements after a kidney transplant will be presented in a separate case report.

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