Physical Activity and Kidney Disease

By Cassianne Robinson-Cohen and Ian de Boer, MD, on behalf of the ASN CKD Advisory Group

A growing body of evidence suggests that lifestyle approaches can yield significant benefits for patients with chronic kidney disease (CKD). Although exercise is not routinely advocated in patients with CKD, it delivers a broad range of health benefits and may prevent cardiovascular complications and disease progression in this patient population. Regular aerobic and resistance training exercise of an intensity and duration tailored to the patient should be considered as an integral treatment option in all patients with CKD.

Physical inactivity is an underlying cause of cardiovascular disease (CVD). Observational studies in the general population have consistently reported that greater physical activity is associated with lower risks of myocardial infarction, stroke, and cardiovascular death (1–3). Physical inactivity contributes to obesity, diabetes mellitus, and hypertension, which are each independently associated with the development of CVD and a decline in functional status.

Exercise stimulates glucose uptake by skeletal muscle, thereby reducing insulin secretion and promoting lipolysis (4). Exercise also contributes to a fall in systemic blood pressure and a reduction in body mass (5, 6). In controlled trials in the general population, moderate physical activity consisting of aerobic, resistance, and combination training improves fasting and postprandial glucose levels, improves and maintains weight loss, raises HDL cholesterol, lowers LDL cholesterol and triglycerides, lowers blood pressure, and probably lowers inflammation and improves endothelial function. On the basis of these results, guidelines from the American Heart Association and the American College of Sports Medicine recommend either moderate-intensity exercise 5 days per week for a minimum of 30 minutes, strenuous exercise 3 days per week for 20 minutes, or a combination of these activities.

The presence of CKD is associated with substantial increased risks of cardiovascular events, disability, and a shortened lifespan. This increased risk can be partly explained by a concomitant increase in traditional risk factors for CVD, such as diabetes mellitus and hypertension. But chronic renal dysfunction alone is also an independent risk factor for CVD. In fact, the majority of individuals with moderate CKD die of CVD rather than progress to ESRD. The major cardiovascular events seen in CKD patients include myocardial infarction and cardiac arrest, stroke, and peripheral vascular disease. Efforts focused on the prevention and management of CVD in patients with CKD are imperative.

Diabetes, obesity, hypertension, and the presence of kidney dysfunction per se lead to activation of the renin-angiotensin system, oxidative stress, endothelial dysfunction, elevated asymmetric dimethyl arginine, low-grade inflammation with increased circulating cytokines, and dyslipidemia (7). These metabolic disturbances are highly prevalent both in CKD patients (8, 9) and in physically inactive individuals (10), and they augment the risks of microvascular and macrovascular disease. Inasmuch as exercise is well recognized as a therapeutic intervention that can improve the physiologic, functional, and psychological deterioration that accrues as a result of a sedentary lifestyle, it is plausible that greater physical activity may temper the metabolic disturbances of CKD and reduce the risks of kidney disease progression and cardiovascular events (Figure 1).

In patients with ESRD, several randomized controlled trials have reported that performing aerobic and/or resistance training during dialysis time, during nondialysis time, or at home can improve many indices of health and function, such as peak oxygen consumption, HDL and LDL cholesterol concentrations, left ventricular mass index, ejection fraction, cardiac output index, stroke volume index, heart rate, quality of life, depression, physical functioning, bodily pain, and work capacity (Table 1) (11). In these trials, aerobic exercise training was typically prescribed for three to four sessions/week for 30–60 minutes per session, at moderate intensity, and was composed of cycle ergometer training, walking/jogging, aerobics, calisthenics, swimming, or ball games. These studies demonstrate that exercise can counteract the physiologic, functional, and psychological wasting associated with ESRD.

In the predialysis CKD setting, a few small trials have investigated the effects of physical activity interventions on a broad spectrum of physiologic indices (Table 1). Studies that have investigated the effects of resistance training programs in CKD patients have found that muscle endurance programs administered three times per week for 12 weeks cause a significant reduction in levels of inflammation markers (C-reactive protein and IL-6) (12) and a significant increase in muscular strength, dynamic endurance, walking capacity, and functional mobility (13).

In addition to the beneficial effects on risk for CVD, physical function, and psychological well-being, physical activity may slow the progression of CKD. One small study of the effect of regular aquatic exercise in patients with moderate chronic renal failure assigned 17 adults with chronic renal failure to low-intensity aerobic exercise in the pool for 12 weeks, twice a week, with sessions lasting for 30 minutes, and matched them to nine control participants who remained sedentary (14). The participants in the exercise group showed significant reduction in serum cystatin-C levels and enhancement of creatinine clearance, whereas no such change was noted in the control group.

Recent evidence also suggests that greater physical activity is associated with a lower risk of rapid kidney function decline among older adults (15). In this large study of community-based older adults, the two highest physical activity groups had a 28 percent lower risk of rapid kidney function decline, defined by the loss of more than 3 mL/min per 1.73 m² per year in the GFR (calculated using serum cystatin C), compared with the two lowest physical activity groups, accounting for potential confounding characteristics. Additionally, in the Nurses’ Health Study, women in the highest physical activity group were 35 percent less likely to have albuminuria than were women in the lowest physical activity group (16).

Modalities to delay or prevent the onset of cardiovascular complications and to slow the progressive loss of kidney function in the CKD population are urgently needed. A large body of evidence suggests that regular aerobic and resistance training exercises of moderate intensity and medium duration could help correct the disease processes underlying these adverse outcomes. Even without randomized controlled trials proving that physical activity prevents cardiovascular and renal events, this body of evidence is sufficiently robust to motivate action. We recommend that physical activity tailored to the individual should be routinely advocated in patients with CKD.

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References

Figure 1
Exercise and kidney health
Chronic Kidney Disease
Physical activity
Cardiovascular disease
Loss of physical function
Insulin Resistance
Inflammation
Endothelial Dysfunction
Dyslipidemia
Oxidative Stress
Hypertension
Progression of kidney disease
Loss of physical function


Table 1

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<th>Setting</th>
<th>Modality, frequency and duration of exercise treatment</th>
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| End-stage renal disease, intradialytic | **Aerobic training**<br>• Cycle ergometer (17, 18) 30–45 min, 3–4 times per week for 6–20 weeks<br><br>**Strength training**<br>• Lower body strength exercise (19, 20) | • Increase in peak oxygen consumption<br>• Increase in peak heart rate<br>• Increase in duration of graded exercise stress test<br>• Increase in physical performance<br><br>**End-stage renal disease, interdialytic/home-based therapy** | **Aerobic training**<br>• Walking (21)<br>• Calisthenics (22, 23)<br>• Cycle ergometer (21)<br>• Swimming (23) 45–60 min, 3–4 times per week for 6–20 weeks<br><br>**Strength training**<br>• Upper and lower body strength exercise (23) 3–4 times per week, 45 min per session | • Increase in maximal aerobic capacity<br>• Decrease in total triglyceride levels<br>• Increase in HDL cholesterol<br>• Decrease in fasting plasma insulin levels<br>• Improvement in glucose disappearance rates<br>• Reduction in coronary risk factors<br>• Increase in self-reported quality of life<br>• Decrease in prevalence of clinical depression<br><br>**Chronic kidney disease, home or training center** | **Aerobic training**<br>• Aquatic exercise (14) 3–4 times per week, 45–60 min per session for 6–20 weeks<br><br>**Strength training**:<br>• Upper and lower body resistance training (12) 3–4 times per week, 45 min per session | • Reduction in cystatin C levels<br>• Reduction in blood pressure<br>• Enhancement of creatinine clearance<br>• Reduction in serum C-reactive protein and IL-6<br>• Increase in type I and type II muscle fiber cross-sectional areas<br>• Decrease in heart rate<br>• Increase in thigh muscular function<br>• Increased muscular strength<br>• Increased dynamic endurance<br>• Increased walking capacity<br>• Increased functional mobility