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# Cardiovascular and Functional Capacity of Patients with Knee Osteoarthritis

*Zuhal Kunduracilar and Kartal Selici*

## Abstract

Patients suffer from pain and disability and have associated reductions in muscle and cardiopulmonary function. Patients with knee and hip OA have a 15–20% decrease in aerobic capacity. The reduced aerobic capacity of patients with lower limb osteoarthritis affects their independence in performing everyday activities. More research is needed to determine the optimal types and dosing of aerobic conditioning with osteoarthritis. Persons at risk for osteoarthritis have one or more of the following risk factors: age over 50, female gender, a first-order family member with OA, previous history of a major knee or hip injury or surgery, obesity, history of joint trauma, or a job requiring bending and carrying. Hip osteoarthritis can also be secondary to developmental defects. Disability not only reduces the quality of life for individuals but also jeopardizes their ability to live independently; it increases the risk of hospitalization, institutionalization, and mortality and is a major driver of healthcare costs due to arthritis.

**Keywords:** osteoarthritis, cardiovascular disease, aerobic capacity, functional capacity

## 1. Introduction

Hypertension, diabetes mellitus, cardiovascular diseases, and osteoarthritis (OA) are the leading diseases of the most common disease clusters [1, 2]. Knee OA is a common health problem in the general population [3]. It is characterized by the abrasion of joint cartilage, changes in the extracellular matrix, subchondral bone ossification, and osteophyte formation [4]. The socioeconomic load of OA, which has a serious morbidity and disability rate, is very heavy. In the United States, 30.8 million patients with OA caused a medical expenditure of over 340 billion dollars between 2008 and 2011 [5]. The worldwide prevalence of symptomatic knee OA is increasing [6].

The most common localization of OA is the knee joint, and symptomatic knee OA affects 24% of the general population [7]. The fact that hypertension, diabetes, and cardiovascular diseases are found together with OA has led to the speculation of a metabolic “OA phenotype” [2]. It was hypothesized that obesity, dyslipidemia, impaired fasting blood sugar, and hypertension contribute to the incidence and progression of OA, which, in turn, led to another hypothesis that OA is an independent metabolic risk factor for cardiovascular diseases [8, 9]. A series of cross-sectional

studies showed a positive relationship between OA and cardiovascular diseases and metabolic syndrome [2, 10, 11].

In 2017, Kendzerska et al. in a study comprising 18,490 patients with 10.0% hip OA, 15.3% knee OA, and 16.3% hand OA found that 31.9% cardiovascular events occurred in approximately 13.4 years in these patients, especially in the knee OA group. They also mentioned that the walking difficulty in knee OA severely increased the risk of a cardiovascular event.

Many cardiovascular events could be prevented by managing OA, with an increase in the cardiovascular capacity and mobility [12]. A low socioeconomic level has been reported to be directly related to the incidence of age and obesity [13, 14]. A low income level, educational status, prolongation of life, and obesity were the important factors in the increase of OA in Brazil [15]. De Rezende et al. in their study comprising 198 patients with OA imparted a training to 150 of them. The physical activity level before the training was mild in 11 participants, moderate in 12 participants, and high in 2 participants, and after the training, it was mild in 74 participants, moderate in 40 participants, and high in 9 participants [15].

## **2. Motivators and obstacles of physical activity in patients with knee OA**

Physical activity is especially accepted as a treatment method for patients with cardiovascular, vascular, and metabolic diseases. The World Health Organization recommends daily recreational or leisure activities, transportation, profession, household chores, games, sports, and planned exercises in the context of family and community activities [16]. Patients with OA typically have lower levels of physical activity compared with the general population [17].

In 2017, Kanavaki et al. conducted a systematic review of qualitative evidence on the inhibitors and facilitators of physical activity in knee and hip OA. A total of 5449 studies were identified; of these, 2657 abstracts were screened and 51 full texts were evaluated. Seven authors were contacted for more information. Ten studies with qualitative metadata that included 173 middle-aged patients were reviewed. The selected studies were found to be of moderate and high quality. The results suggested that half of the studies did not have a clear data analysis or were not well defined and only a few provided the desired characteristics. In the present study, the inhibitors and facilitators were examined under three conceptual headlines: physical health, interpersonal and psychological factors, and socioenvironmental factors. Facilitators in physical health included mobility, getting rid of symptoms, and health. Facilitators in interpersonal and psychological factors included beneficial exercise, information about exercise, maintaining motivation despite OA, organizations, prioritization, personal effort, responsibility, and the will to be physically more active. Facilitators in social environment included support from health professionals and social support to make the physical activity easier. Inhibitors in physical health included pain and other symptoms and perceived functional limitations. Inhibitors in interpersonal and psychological factors included non-effective physical activity, harmful or suspicious activity, loss of motivation, and loss of behavioral regulation. Inhibitors in social environment included lack of advice and encouragement from health workers, social comparison as demotivation, and lack of social support [18].

In 2017, Gay et al. conducted a qualitative study on the motivation and inhibitors for physical activity in patients with knee OA. A total of 27 patients with a mean age of 67 years were included in the study, of which 17 were women. The physical motivators for physical activity included well-being, reduced pain, and self-perception;

personal activity included life style and psychological well-being; social activity included relationships and opinions of friend circles; and for environmental activity included living conditions. The motivators were found to differ according to gender. Inhibitors for physical activity were as follows: psychological—fear of pain and lack of motivation and physical—knee pain and asthenia. Moreover, life events such as potential depression and hospitalization were also identified as inhibitors for physical activity [19].

Nociceptive and neuropathic pain accompanying the disease leads to disorders in mood and sleep, which, in turn, lead to a decrease in the quality of life [20]. In 2017, Aşkın et al. conducted a study comprising 60 patients with knee OA with neuropathic pain and found that 66.7% had significantly reduced functional capacities and quality of life as a result of the clinical evaluation carried out with the chair stand test. Although inhibitors and facilitators increase the effectiveness of treatment in the development of cardiovascular and functional capacity within OA management, they also help decrease the symptoms in a shorter period of time, contribute to the quality of life, and thus facilitate the decrease of morbidity-induced deaths [21].

### **3. Comorbid diseases in OA**

In a recent meta-analytic study by Hall et al., 40% of patients with OA were found to have cardiovascular diseases and 10–14% of those who had diabetes mellitus together with OA also suffered from obesity and metabolic syndrome [22, 23]. Calders et al. performed a systematic review and meta-analysis in which 17 studies were examined. In this study, worsening OA-related pain was associated with comorbid disease. Studies also found that heart disease, hypertension, and diabetes mellitus associated with OA led to a further deterioration in physical functioning [24].

Chronic inflammation is a global major health problem that affects tens of millions of people in North America and Europe [25, 26]. The long-term use of nonsteroidal anti-inflammatory drugs in OA increased the blood pressure and even leads to heart attack, stroke, heart failure, arrhythmias, and sudden cardiac death. The presence of these diseases accompanied by OA increased the danger even more [27]. Among joint-related diseases, patients with osteoarthritis (OA) are the most prone to develop hypertension. This situation constitutes a risk factor for cardiovascular and cerebrovascular diseases [28]. Patients with OA have an increased risk of experiencing a stroke because of a decrease in the mobility [29]. With increasing elderly population, obesity and decreased physical activity have increased the incidence and prevalence of OA, which, on the other hand, have accelerated vascular comorbidity [30]. Along with vascular diseases, the overlap of OA prevalence has also raised the question of possible common mechanisms and the development of preventive and therapeutic strategies for this situation [31].

The chronic or intermittent increase in systemic inflammation suggests a connection between OA and vascular diseases. OA is a noninflammatory systemic chronic disease. Systemic inflammatory mechanisms in OA are still being discussed [8, 31, 32]. For example, chronic and low-grade inflammation occurs with age, and OA is a disease that more often occurs with an advanced age. However, changes also occur in the blood immune system in these patients who were suggested to have a systemic change in the inflammatory process that is associated with OA independent of age [31, 33–35]. Among OA and cardiovascular diseases, there are inflammatory cytokines (e.g., interleukin-6) [36, 37], oxidative pathways [38, 39], and C-reactive protein containing [31, 40, 41] common inflammatory mediators.



Inflammation leads to vascular endothelial dysfunction in places with previous cardiovascular events. Impaired flow-mediated dilation responses in patients with OA in this group showed a weak vascular endothelial function. This situation might be a marker for peripheral vascular dysfunction [31, 42].

Osteoprotegerin (OPG), which is a systemic vascular mechanism, a key in the bone resorption modifier, and associated with vascular endothelia, is one of the precursors of early atherosclerosis. OPG plays a role in both bone remodeling and atherosclerosis. OPG serum levels were found to be high in patients with advanced OA. A high OPG level may lead to the progression of OA and dysfunctional vascular remodeling [31, 43]. Khazraji et al. emphasized in a compilation study, examining the relationship between OA and cerebrovascular disease, that the common relationship between cerebrovascular hemodynamics and cognitive functions in people with and without OA risk needs to be explored [31].

The decrease in aerobic capacity in the lower extremity OA negatively affects independence in daily life activities. Studies have shown that various aerobic exercises, such as walking, running, cycling, aquatic exercises, and aerobic dance, have a positive effect on pain, joint stiffness, functional capacity, and aerobic capacity in patients with hip and knee OA [44]. Studies have stated that walking in patients with OA can improve aerobic capacity and physical activity without increasing the stress in the joints and can be used safely [45]. In 2011, Escalante et al. conducted a systematic review of the effect of exercises on functional aerobic capacity in patients with lower extremity OA. The study found that although aerobic exercise programs were recommended for patients with knee and hip OA, only a few randomized control studies were performed. They have stated that there was no consensus in terms of the content, duration, and frequency of the exercise programs, and the exercise programs including tai chi, aerobic, and mixed exercises had better results compared with hydrotherapy [45].

Although swimming is the ideal exercise for patients with OA, only a few studies have investigated the effect of regular swimming on vascular dysfunction and inflammation. Similar studies have shown that ground-based exercises have similar benefits. Alkatan et al. conducted a randomized controlled study with middle-aged patients with OA in 2016. One group was given supervised swimming and the other group cycling training for 12 weeks. After the training, central arterial stiffness determined by carotid femoral pulsation wave velocity decreased in both groups. Also, according to simultaneous ultrasonography and applanation tonometry, the carotid artery stiffness decreased. In the swimming group, the evaluation of the brachial flow-mediated dilation showed a development in vascular endothelial functions, but no change was observed in the cycling group [42].

#### **4. Factors affecting cardiovascular function and functional capacity**

Garza et al. conducted a study in the year 2017 with 33 patients aged more than 40. All the patients were diagnosed with OA. They have founded that decreased ischiotibial muscle flexibility reduced the functional capacity, also flexibility and functional capacity increased and pain decreased through exercise [46]. Obesity is considered to be one of the most important and potentially preventable risk factors for OA. Besides the mechanical load of obesity on OA, leptin, visfatin, adiponectin, and resistin were found to have metabolic effects on the pathogenesis and progression of adipokines and others. Obesity has an important role in the reduction of functional capacity in OA, as a result of the disability [47].

Difficulty in walking in people with hip and knee OA constitutes a great risk for all-cause mortality and cardiovascular events [48, 49]. In 2016, Hawker et al.

conducted a study using 1996 patients (with a mean age of 71.4 years) with hip and knee OA and found that 77.7% had hypertension, 54% had cardiovascular diseases, 42.9% had obesity, and 15.3% were smokers. The HAQ walking difficulty score in these patients was found to be two-third. This interval showed that these patients had medium-to-serious disabilities. Of these patients, 54.9% used a walking aid. An average of 6.1 years later, 184 people (51.3%) experienced one or more complications specific to diabetes; 5.7 years later, 191 patients experienced cardiovascular events [50].

## **5. Approaches to increase cardiovascular function and functional capacity**

Besides facilitating weight loss in the management of knee OA [51, 52], exercise is strongly recommended because of its positive changes in symptoms and functional capacity [53, 54]. The aquatic environment allows an individual to exercise because it reduces the load on the joints. Recent studies compared ground-based exercises with aquatic exercises in terms of lower extremities of patients with OA and found that aquatic exercises statistically significantly reduced the pain [55]. Kunduracilar et al. investigated the effect of two different aquatic exercises on pain, functional and exercise capacity, and balance with a program that lasted for 4 weeks, 5 days a week, implemented on 89 patients diagnosed with OA. They applied ground-based exercises together with lower extremity aquatic exercises to one group and ground-based exercises together with upper and lower extremity exercises and body exercises to the other group. The control group was only given ground-based exercises. All three groups were positively affected in terms of pain, balance, and functional capacity. However, the second group, where both exercises were given, was found to have the best outcome in terms of increased functional and exercise capacity [56]. Bernad-Pineda et al. conducted a study comprising 1849 patients with knee (61.5%) and hip (19%) OA in 2014 and found that a decrease in quality of life also led to a decrease in functional capacity [57].

The studies showed that exercise played an important role in the management of OA-related symptoms and also contributed to the functional capacity in the everyday life activities of the patients. In 2017, Peeler et al. went on with the hypothesis that unsafe and ineffective exercise practices might exacerbate the symptoms in the joint. They used a new treadmill, without the risk of exacerbation during exercises, in patients with pathology in the lower extremities, within a low-load exercise training that allows lower body positive pressure (LBPP). The treadmill uses a waist-high air chamber filled with positive air pressure (i.e., LBPP) to accurately and reliably diminish body weight during exercise. The 12-week LBPP-supported treadmill program in this study comprising 31 patients increased the functional capacity of the patients and allowed them to freely carry out their daily activities. The study concluded that the 12-week LBPP-supported treadmill program was a safe exercise for patients with mild and medium OA without exacerbating the symptoms [58].

Another way to strengthen the muscles via exercise is the whole-body vibration (WBV). In recent years, WBV has been used frequently to improve muscle performance [59]. Many studies have documented that WBV is very effective in increasing the functional capacity and metabolism in age-related muscle atrophies [60, 61]. In this training, contrary to the other exercise programs, less pressure was put on the joint. Recent studies have shown that this technique was statistically more successful in reducing symptoms and regaining functions in patients with OA [62]. Bokaeian et al. in a study in 2016 applied strengthening training for the quadriceps and hamstring muscles to a group with knee OA (n = 139) and the

WBV technique along with the strengthening exercises to another group (n = 15) in three sessions per week for a total of 8 weeks. The results showed an increase in quadriceps muscle strength and functional activity [63]. In 2017, Waller et al. conducted a 4-month program of postmenopausal high-intensity aquatic resistance training, which included 87 postmenopausal patients with mild OA, to examine its effect on body composition and walking speed of the patients. After the study, the patients were followed up for 12 months. The findings revealed that the walking speed increased and the cardiovascular system developed; however, while the gains in the increased walking speed were maintained, the cardiovascular gains were lost in the 12-month follow-up [64].

## 6. Conclusion

In conclusion, the assessment of cardiovascular and functional capacity and the inclusion of training programs in the treatment of OA reduced the load of the disease. Besides, these programs could reduce the frequency of comorbid illnesses, hospital admissions, and deaths associated with OA. It could increase the quality of life of the patients and is believed to make positive changes on survival. However, further studies in this regard might be more beneficial, and OA grievances should be prioritized in health policies.

## Conflict of interest

The authors declare no conflict of interest.

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