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# An Overview of the Connection Between Knee Osteoarthritis and the State of Cardiorespiratory Health

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**Abstract**

***Objective:*** Osteoarthritis (OA) is a multifactorial degenerative disease characterized by a range of morphological and biochemical alterations to the joint capsule and synovial membrane, as well as bone hypertrophy and articular cartilage loss at the margins. Osteoarthritis (OA) is one of the most common causes of impairment in adults. This review aims to determine whether knee osteoarthritis and the state of cardiorespiratory health are correlated. Reviewing the relationship between knee osteoarthritis (OA) and cardiorespiratory health status is important because OA's systemic effects are becoming more well-acknowledged. To improve quality of life and lessen the strain on healthcare systems, comprehensive management strategies that address not only joint health but also an individual's total cardiovascular and respiratory well-being must take this relationship into account.

***Study design:*** Research articles were retrieved for this systematic review from reliable academic search engines such as Google Scholar, IEEE Xplore, Springer, and Elsevier. To obtain answers to the research questions, appropriate keywords are utilized in the literature search from reputable sources, such as Web of Science (WOS), and Scopus. The current study includes 80 papers. They underwent an extensive evaluation using the Prisma methodology for systematic review.

***Result and conclusion:*** Given that there is a favourable link between knee osteoarthritis (OA) and cardiorespiratory health status, this review has the potential to revolutionize the management of OA by promoting a more exhaustive treatment approach. Cardiorespiratory fitness assessments may be incorporated by medical professionals into standard OA treatment, resulting in specific therapies that promote cardiovascular and joint health. This may lead to increased cardiovascular health, increased mobility, and better overall patient outcomes, which would eventually save healthcare expenses and raise the standard of living for those who have osteoarthritis.

**Keywords:** Activity limitation, Psychological health, Prisma, Exercise test, WOMAC, 6-minute walk test.

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## INTRODUCTION

Osteoarthritis (OA) is a multifactorial degenerative ailment that is defined by morphological and biochemical alterations to the joint capsule and synovial membrane, bone hypertrophy, and articular cartilage loss at the margins[1]. One of the most prevalent reasons for disability in adults is OA.Due to several variables related to chronic osteoarthritis, activity limitation is one of the primary consequences[2-4]. These factors can also cause other related health issues, such as respiratory and cardiovascular diseases[5,6].Following the age of 45, one's likelihood of OA increases substantially with each decade, with the medial compartment of the knee being the most common site of OA manifestation[7,8,9].

Cardiorespiratory fitness (CRF) is the capacity of the respiratory and circulatory systems to supply skeletal muscle mitochondria with adequate oxygen for the energy generation required during physical activity.[10,11] According to a 2013 Policy Statement published by the American Heart Association, CRF is the only significant risk factor that is not commonly evaluated in general or specialized healthcare settings.[12,13]

This review aims to determine whether knee osteoarthritis and the state of cardiorespiratory health are correlated. Reviewing the relationship between knee osteoarthritis (OA) and cardiorespiratory health status is important because OA's systemic effects are becoming more well-acknowledged. Reduced physical activity has been linked to knee OA, a common ailment in older populations that might affect cardiorespiratory fitness[5]. To enhance life quality and lessen the strain on healthcare systems, comprehensive management strategies that address not only joint health but also an individual's total cardiovascular and respiratory well-being must take this relationship into account.

## RESEARCH QUESTIONS

- What connection exists between physical activity and knee OA?
- How cardiorespiratory health is related to knee osteoarthritis?

## METHODS

**Inclusion and exclusion criteria:**

A few specified criteria were applied to the initial pick, which included the language used in the paper, the year of publication, and the subject's significance to the desired field.

- Research articles that were written entirely in English are included in this study.
- The review contains studies that evaluated baseline or altered cardiorespiratory state with osteoarthritis in the knee.
- To ensure relevance and current evidence, only studies published within the last 15 years were considered in the review.
- The review omitted studies that did not provide sufficient detail or methodological quality to evaluate cardiorespiratory outcomes.
- This analysis included articles from respectable publishers, including Elsevier, Springer, Wiley, BMC, and others.
- After reading the abstracts of those research, the publications that describe the domain that the paper is presenting are included.

**Search strategy:**

A comprehensive literature examination was done using databases like PubMed, Embase, the Cochrane Library, and Web of Science to investigate the connection between knee osteoarthritis and cardiorespiratory health. "Knee osteoarthritis," "cardiorespiratory health," "respiratory function," and "aerobic capacity" were among the search phrases used. Only English-language papers up to 2024 were included in the search. A Prisma model, which depicts the information flow across the multiple review processes, has served as the foundation for the selection process for an article.

**Selection of the paper:**

The papers were located and selected from several trustworthy sources, including Web of Science (WOS), Scopus, and Science Citation Index Expanded (SCIE), based on titles relevant to our inquiry. Following an in-depth analysis of journals associated with our primary keywords, 80 papers were selected for this methodical assessment. These

publications were chosen for our study according to predefined criteria that indicated their eligibility. *Fig. 1* shows a graphical representation of the search results for this review.

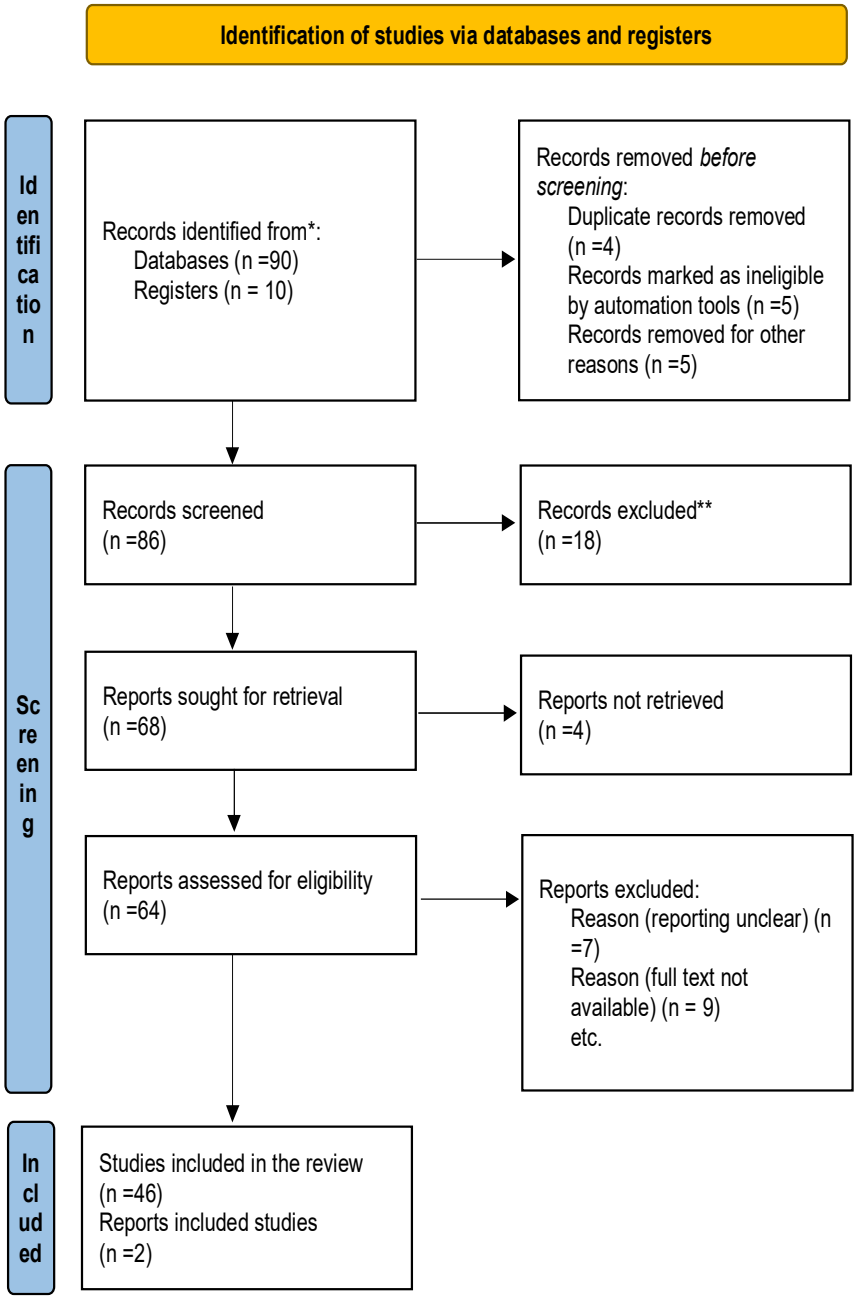


**Fig. 1:** PRISMA Diagram

## LITERATURE REVIEW

Any paper examining the relationship between knee osteoarthritis and cardiorespiratory disorders must include a literature review in order to fully comprehend the current state of research. By carefully reviewing relevant papers, an author can identify knowledge gaps, establish the scene for their investigation, and make sure their work contributes to the body of data. To further ensure that the research is both relevant and sound academically, a literature review aids in identifying important variables, techniques, and theoretical frameworks that can guide the study design.

**Connection between physical activity and knee OA:**

A person's capacity to exercise is greatly impacted by knee OA, which results in a complicated interaction between joint health and functional mobility[14,15]. Pain, stiffness, and decreased range of motion are the hallmarks of knee OA, which frequently restricts physical activity levels and results in muscle weakening and a lower quality of life[16]. Due to the condition's degenerative nature, decreased activity can worsen joint degeneration, which further reduces function and mobility. Physical inactivity is further exacerbated by psychosocial variables including fear of pain or damage, which frequently lead to movement avoidance[17,18]. Therefore, a rigorous evaluation is required in this respect.

**Table 1:** association between knee OA and physical activity(PA)

| Author | Aim of the study | Study design | Outcome measures | Sample size | Findings | limitations |
|---|---|---|---|---|---|---|
| De Groot *et al*[19] | to evaluate the level of PA in individuals with hip and knee end-stage OA. | prospective follow-up study. | WOMAC, SF-36 | 40 hip OA, 44 knee OA | Both OA groups' actual levels of PA were considerably and significantly lower | Small sample size, Control data was extracted from a database. |
| Rosemann *et al*[20] | To find out indicators of physical activity in people with OA in the hip or knee was the study's main goal. | Cross-sectional | International Physical Activity Questionnaire (IPAQ),the Patient Health Questionnaire, Arthritis Impact Measurement Scale | 1250 | The results highlight how both physical and psychological variables affect OA patients' PA. | IPAQ has not been particularly validated for use with arthritic patients, despite being a valid and reliable measure for assessing PA in adults. |
| Shih *et al*[21] | determines the parameters linked to physical inactivity in persons with arthritis and calculates the prevalence of leisure-time physical activity nationwide. | Cross-sectional | Level of physical activity | 6829 | Adults with arthritis had lower activity profiles than their contemporaries without arthritis, and their PA levels are inadequate. | Causation cannot be determined, When assessing a person's level of physical activity and whether they have arthritis, there is a chance of misclassification bias because the data is self-reported and susceptible to recollection bias. |
| White *et al*[22] | Examining step-defined daily walking and incident functional restriction in individuals with or without OA | observational | StepWatch activity monitor | 1788 | Walking more often is linked to a lower incidence of activity limitation. | Clinical trials should have investigated the threshold. The relationship between moderately intense steps was not investigated. |
| Dijk *et al*[23] | to ascertain the connection between limits in activities and comorbidities, cognitive functioning, and bodily functions in older patients with knee or hip OA | Cross-sectional cohort | WOMAC, timed walking test, | 288 | Pain is the main factor influencing self-reported activity restrictions in hip or knee OA, with range of motion, muscular strength, and comorbidity playing a smaller role. | Small sample size. Hospitals and rehabilitation facilities provided the patients for this investigation. Therefore, it is not possible to generalize the findings of this study to the entire OA community. |

| Author | Aim of the study | Study design | Outcome measures | Sample size | Findings | limitations |
|---|---|---|---|---|---|---|
| Rosemann *et al*[24] | To assess PA-related traits in a large group of patients receiving primary care | Cross-sectional | International physical activity questionnaire (IPAQ), Patient health questionnaire (PHQ-9), the arthritis impact measurement scale (AIMS2-SF) | 1250 | The main determinants of the IPAQ score in patients with OA of the knee were pain, social interactions, and lower limb limitation. | There isn't a recognized, accurate, and trustworthy tool to evaluate PA in OA patients. |

## Relationship between knee OA and cardiovascular health:

It is generally known that knee OA affects PA levels. Numerous respiratory and cardiovascular disorders can be prevented and treated by physical exercise, which has a significant impact on cardiopulmonary health[25]. It promotes effective respiratory function by strengthening the respiratory muscles, expanding lung capacity, and improving oxygen exchange[26,27]. The link between physical activity and cardiopulmonary health is further highlighted by its ability to lower systemic inflammation and improve vascular flexibility, two factors crucial to maintaining optimal cardiopulmonary function[28,29]. To understand how decreasing PA contributes to the development of cardiovascular diseases in individuals with knee OA, it is imperative to look into this connection. The impact of less physical activity on cardiovascular health is displayed in the following table.

**Table 2:** The impact of reduced physical activity on cardiopulmonary health

| Author | Aim of the study | Study design | Outcome measures | Sample size | Findings | limitations |
|---|---|---|---|---|---|---|
| Bouchard *et al*[30] | Objective measurements of cardiorespiratory fitness, obesity, and functional restriction to see whether there is an interaction between these variables and functional limitation in a group of older persons who are sedentary and abdominally fat. | Cross-sectional | maximal treadmill test, | 146 | Functional restriction is associated with cardiovascular health. | The sample is homogeneous, so generalization cannot be done. |
| Park *et al*[31] | to ascertain whether knee OA is linked to CVD risk and all-cause mortality and whether the relationship varies depending on exercise activity | Cohort | Self-administered questionnaire | 7572 | Independently, knee OA was linked to a higher risk of cardiovascular disease. | It is impossible to identify the causal relationship. as the amount of activity measured by a self-report questionnaire, therefore recall bias cannot be disregarded. |
| Sutbeyaz *et al*[32] | to ascertain whether knee OA lowers quality of life and exercise ambulatory capacity. | Cross-sectional | maximal cardiopulmonary exercise test, 6-minute walk test (6-MWT), perceived exertion (RPE), anthropometric measurements, body composition assessment, WOMAC, SF 36 | 56 | The cardiorespiratory fitness and ambulatory capacity of those with knee OA were lower than those without the condition. | Small sample size |

| | | | | | | |
|---|---|---|---|---|---|---|
| Steele *et al*[33] | to ascertain whether the aerobic capacity of individuals with knee OA is lower than that of age- and gender-matched healthy controls. | Cross-sectional | submaximal cycler ergometer test | 44 | The aerobic capacity of those with OA of the knee is lower than that of age and gender-matched healthy controls. | Small sample size |
| Kalantri *et al*[34] | to assess cardiovascular endurance in older adults with OA knee | Cross-sectional | 2min walk test | 20 | Overall cardiovascular endurance is lower in older people with OA knees, and bilateral OA knees are less resilient than unilateral ones | The sample size is small |

## RESULTS

The study showed that knee OA and cardiorespiratory health are significantly correlated, emphasizing that individuals with knee OA frequently have impaired pulmonary and cardiovascular function. Clinical data analysis revealed that those with knee OA had lower levels of exercise tolerance and VO2 max, two important indicators of cardiorespiratory fitness. These restrictions are linked to a reduction in overall functional capacity as a result of less physical activity brought on by joint pain and stiffness. The interconnectedness of these disorders is further highlighted by the observation that systemic inflammation linked to OA exacerbates cardiovascular risk factors.

The results further emphasized the significance of focused therapies to improve knee OA patients' joint and cardiorespiratory health. It has been demonstrated that techniques like resistance and aerobic training regimens can reduce joint pain and increase cardiovascular endurance. The long-term effects on mobility and general health could be lessened by improving preventive measures through early identification of those at risk for both disorders. In order to maximize outcomes for patients with knee OA, these findings advocate for an integrated approach in clinical practice that combines orthopaedic and cardiopulmonary therapy.

## DISCUSSION

The study's conclusions show the connections between knee OA, exercise, and cardiorespiratory health, underscoring the difficulties and possibilities in treating this condition. It is evident that knee OA negatively impacts physical activity and mobility, which can lead to a number of deconditioning episodes and compromised cardiorespiratory health. These consequences raise the likelihood of developing secondary health issues, such as metabolic and cardiovascular illnesses, in addition to lowering quality of life.

Numerous studies have demonstrated that a variety of exercise programs, such as strength and endurance training, can improve cardiovascular health and physical activity[35,36].A thorough, patient-centred approach to knee OA management is essential in light of these findings. Strength training, flexibility exercises, and low-impact aerobic workouts are examples of integrative techniques that can effectively enhance functional outcomes and cardiorespiratory fitness while reducing joint stress[37,38]. These interventions, which are customized to each person's abilities and preferences, can lessen the burden of disease and interrupt the cycle of inactivity[39]. Physical activity should also be complemented by behavioural therapy, dietary changes, and weight control to reduce systemic inflammation and comorbidities linked to OA[40-42].

This study also emphasizes how crucial early intervention and preventative strategies are for maintaining systemic health and mobility in people at risk for knee OA. Public health campaigns should emphasize the importance of leading an active lifestyle, along with particular recommendations for joint-friendly activities[43,44]. In populations susceptible to the combined problems of joint degeneration and deteriorating cardiorespiratory health, cooperation between healthcare professionals and community-based initiatives can improve patient involvement and adherence[45-48].

Future studies should focus on developing precise recommendations for the kind, quantity, and level of exercise that will best balance systemic fitness and joint health in people with osteoarthritis

in the knee. Management procedures could be further improved by investigating cutting-edge rehabilitation approaches like group treatment programs, digital health technologies, and new modalities like aquatic therapy. To improve long-term results and the well-being of those who are impacted, it is imperative to address the interactions among knee OA, physical activity, and cardiorespiratory health.

## CONCLUSION

In summary, the complex relationship between osteoarthritis in the knee and cardiorespiratory health emphasizes the necessity of treating these illnesses holistically. According to the research, decreased physical activity brought on by stiffness and pain in the joints has a major effect on cardiorespiratory fitness, and systemic inflammation in knee OA may increase the risk of cardiovascular disease. Improving patient outcomes requires interventions like customized exercise regimens and holistic care plans that target cardiovascular and musculoskeletal health. In order to improve mobility, cardiovascular health, and general quality of life for people with knee osteoarthritis, future research should concentrate on examining the processes underlying these disorders and creating integrated therapy approaches.

## REFERENCES


1. Madry, H., Luyten, F.P., & Facchini, A. (2012). Biological aspects of early osteoarthritis.c*Knee surgery, sports traumatology, arthroscopy*, *20*, 407-422.
2. McDonough, C.M., & Jette, A.M. (2010). The contribution of osteoarthritis to functional limitations and disability. *Clinics in geriatric medicine*, *26*(3), 387-399.
3. Machado, G.P., Gignac, M.A., & Badley, E.M. (2008). Participation restrictions among older adults with osteoarthritis: a mediated model of physical symptoms, activity limitations, and depression. *Arthritis Care & Research: Official Journal of the American College of Rheumatology*, *59*(1), 129-135.
4. Jones, N.L., & Killian, K.J. (2000). Exercise limitation in health and disease. *New England Journal of Medicine*, *343*(9), 632-641.
5. Vogiatzis, I., Zakynthinos, G., & Andrianopoulos, V. (2012). Mechanisms of physical activity limitation in chronic lung diseases. *Pulmonary medicine*, *2012*(1), 634761.
6. Jones, N.L., & Killian, K.J. (2000). Exercise limitation in health and disease. *New England Journal of Medicine*, *343*(9), 632-641.
7. Vincent, K.R., Conrad, B.P., Fregly, B.J., & Vincent, H.K. (2012). The pathophysiology of osteoarthritis: a mechanical perspective on the knee joint. *PM&R*, *4*(5), S3-S9.
8. Wise, B.L., Niu, J., Yang, M., Lane, N.E., Harvey, W., Felson, D.T., ... & Multicenter Osteoarthritis (MOST) Group. (2012). Patterns of compartment involvement in tibiofemoral osteoarthritis in men and women and in whites and African Americans. *Arthritis care & research*, *64*(6), 847-852.
9. Lawrence, R.C., Felson, D.T., Helmick, C.G., Arnold, L. M., Choi, H., Deyo, R. A., ... & National Arthritis Data Workgroup. (2008). Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. *Arthritis & Rheumatism*, *58*(1), 26-35.
10. Raghuveer, G., Hartz, J., Lubans, D.R., Takken, T., Wiltz, J. L., Mietus-Snyder, M., ... & American Heart Association Young Hearts Athero, Hypertension and Obesity in the Young Committee of the Council on Lifelong Congenital Heart Disease and Heart Health in the Young. (2020). Cardiorespiratory fitness in youth: an important marker of health: a scientific statement from the American Heart Association. *Circulation*, *142*(7), e101-e118.
11. Mesa, J.L., Ortega, F.B., Ruiz, J.R., Castillo, M.J., Hurtig-Wennlöf, A., Sjöström, M., & Gutiérrez, Á. (2006). The importance of cardiorespiratory fitness for healthy metabolic traits in children and adolescents: the AVENA Study. *Journal of Public Health*, *14*, 178-180.
12. Kaminsky, L.A., Arena, R., Ellingsen, Ø., Harber, M. P., Myers, J., Ozemek, C., & Ross, R. (2019). Cardiorespiratory fitness and cardiovascular disease-the past, present, and future. *Progress in cardiovascular diseases*, *62*(2), 86-93.
13. Kaminsky, L.A., Arena, R., Beckie, T.M., Brubaker, P.H., Church, T.S., Forman, D.E., ... & Williams, M. A. (2013). The importance of cardiorespiratory fitness in the United States: the need for a national registry: a policy statement from the American Heart Association. *Circulation*, *127*(5), 652-662.
14. McDonough, C.M., & Jette, A.M. (2010). The contribution of osteoarthritis to functional limitations and disability. *Clinics in geriatric medicine*, *26*(3), 387-399.
15. Shaheen, A.M., & Ayad, K. (2008). Impact of chronic osteoarthritis of knee joint on postural stability and functional mobility in women. *Bull Fac Ph Th Cairo Univ*, *13*, 19-33.
16. Brody, L.T. (2015). Knee osteoarthritis: clinical connections to articular cartilage structure and function. *Physical Therapy in Sport*, *16*(4), 301-316.
17. Saxon, S.V., Etten, M.J., Perkins, E.A., & RNLD, F. (2021). *Physical change and aging: A guide for*

*helping professions*. Springer Publishing Company.

18. Palmer, K.L. (2024). *Pain, well-being, and physical activity in adults with chronic pain and spinal cord injury* (Doctoral dissertation, University of British Columbia).
19. De Groot, I.B., Bussmann, J.B., Stam, H.J., & Verhaar, J.A.N. (2008). Actual everyday physical activity in patients with end-stage hip or knee osteoarthritis compared with healthy controls. *Osteoarthritis and cartilage*, *16*(4), 436-442.
20. Rosemann, T., Kuehlein, T., Laux, G., & Szecsenyi, J. (2008). Factors associated with physical activity of patients with osteoarthritis of the lower limb. *Journal of evaluation in clinical practice*, *14*(2), 288-293.
21. Shih, M., Hootman, J.M., Kruger, J., & Helmick, C. G. (2006). Physical activity in men and women with arthritis: National Health Interview Survey, 2002. *American journal of preventive medicine*, *30*(5), 385-393.
22. White, D.K., Tudor-Locke, C., Zhang, Y., Fielding, R., LaValley, M., Felson, D.T., ... & Neogi, T. (2014). Daily walking and the risk of incident functional limitation in knee osteoarthritis: an observational study. *Arthritis care & research*, *66*(9), 1328-1336.
23. van Dijk, G.M., Veenhof, C., Lankhorst, G.J., & Dekker, J. (2009). Limitations in activities in patients with osteoarthritis of the hip or knee: the relationship with body functions, comorbidity and cognitive functioning. *Disability and rehabilitation*, *31*(20), 1685-1691.
24. Rosemann, T., Kuehlein, T., Laux, G., & Szecsenyi, J. (2007). Osteoarthritis of the knee and hip: a comparison of factors associated with physical activity. *Clinical rheumatology*, *26*, 1811-1817.
25. Thompson, P.D., Buchner, D., Piña, I.L., Balady, G. J., Williams, M. A., Marcus, B. H., ... & Wenger, N. K. (2003). Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease: a statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity). *Circulation*, *107*(24), 3109-3116.
26. Spruit, M.A., Singh, S.J., Garvey, C., ZuWallack, R., Nici, L., Rochester, C., ... & Wouters, E.F. (2013). An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *American journal of respiratory and critical care medicine*, *188*(8), e13-e64.
27. Nici, L., Donner, C., Wouters, E., Zuwallack, R., Ambrosino, N., Bourbeau, J., ... & Troosters, T. (2006). American thoracic society/European respiratory society statement on pulmonary rehabilitation. *American journal of respiratory and critical care medicine*, *173*(12), 1390-1413.
28. Richter, M.J., Grimminger, J., Krüger, B., Ghofrani, H.A., Mooren, F.C., Gall, H., ... & Krüger, K. (2017). Effects of exercise training on pulmonary hemodynamics, functional capacity and inflammation in pulmonary hypertension. *Pulmonary circulation*, *7*(1), 20-37.
29. Belanger, M.J., Rao, P., & Robbins, J.M. (2022). Exercise, physical activity, and cardiometabolic health: Pathophysiologic insights. Cardiology in review, 30(3), 134-144.
30. Bouchard, D.R., McGuire, K.A., Davidson, L., & Ross, R. (2011). Cardiorespiratory fitness, obesity, and functional limitation in older adults. *Journal of aging and physical activity*, *19*(4), 336-346.
31. Park, D., Park, Y. M., Ko, S. H., Choi, Y.H., Min, D.U., Ahn, J.H., ... & Han, K. (2023). Association between knee osteoarthritis and the risk of cardiovascular disease and the synergistic adverse effects of lack of exercise. *Scientific Reports*, *13*(1), 2777.
32. Sutbeyaz, S.T., Sezer, N., Koseoglu, B.F., Ibrahimoglu, F., & Tekin, D. (2007). Influence of knee osteoarthritis on exercise capacity and quality of life in obese adults. *Obesity*, *15*(8), 2071-2076.
33. Steele, B.E. (2013). *Aerobic Capacity in Individuals with Osteoarthritis of the Knee* (Doctoral dissertation, Auckland University of Technology).
34. Kalantri, G., & Shewale, S. (2021). Cardiovascular endurance among community dwelling elderly population with oa knee-cross sectional study. *Vims journal of physical therapy*, *3*(1), 23-27.
35. Øiestad, B.E., Årøen, A., Røtterud, J.H., Østerås, N., Jarstad, E., Grotle, M., & Risberg, M.A. (2023). The long-term efficacy of strength or aerobic exercise on quality of life and knee function in patients with knee osteoarthritis. A multi-arm randomized controlled trial.
36. Carvalho, M.R.P.D., Sato, E.I., Tebexreni, A.S., Heidecher, R.T., Schenkman, S., & Neto, T.L. B. (2005). Effects of supervised cardiovascular training program on exercise tolerance, aerobic capacity, and quality of life in patients with systemic lupus erythematosus. *Arthritis Care & Research: Official Journal of the American College of Rheumatology*, *53*(6), 838-844.
37. Zhong, Y.J., Meng, Q., & Su, C.H. (2024). Mechanism-Driven Strategies for Reducing Fall Risk in the Elderly: A Multidisciplinary Review of Exercise Interventions.
38. Gangwar, D. Mobility and Strength Training in Older Adults. *Physiotherapy in Geriatric Condition*, 139.
39. Gibson, A. L., Wagner, D. R., & Heyward, V. H. (2024). *Advanced fitness assessment and exercise prescription*. Human kinetics.
40. Dean, E., & Gormsen Hansen, R. (2012). Prescribing Optimal Nutrition and Physical Activity as "First-Line" Interventions for Best Practice Management of Chronic Low-Grade

Inflammation Associated with Osteoarthritis: Evidence Synthesis. *Arthritis*, *2012*(1), 560634.

41. Skou, S.T., Pedersen, B.K., Abbott, J.H., Patterson, B., & Barton, C. (2018). Physical activity and exercise therapy benefit more than just symptoms and impairments in people with hip and knee osteoarthritis. *Journal of orthopaedic & sports physical therapy*, *48*(6), 439-447.
42. Maly, M.R., Marriott, K.A., & Chopp-Hurley, J. N. (2020). Osteoarthritis year in review 2019: rehabilitation and outcomes. *Osteoarthritis and cartilage*, *28*(3), 249-266.
43. Herbolsheimer, F. (2017). *A physically active lifestyle in old age: the role of the physical and social environment* (Doctoral dissertation, Universität Ulm).
44. Odom, E.L. (2015). *The cost of inactivity: differences in total healthcare expenditures and healthcare service utilization between sedentary and active adults with arthritis* (Doctoral dissertation, University of Georgia).
45. Hootman, J.M., Helmick, C.G., & Brady, T.J. (2012). A public health approach to addressing arthritis in older adults: the most common cause of disability. *American journal of public health*, *102*(3), 426-433.
46. Ekelund, L.G., Haskell, W.L., Johnson, J.L., Whaley, F.S., Criqui, M.H., Sheps, D.S., & Lipid Research Clinics Mortality Follow-up Study. (1988). Physical fitness as a predictor of cardiovascular mortality in asymptomatic North American men. *New England Journal of Medicine*, *319*(21), 1379-1384.
47. Loew, L., Brosseau, L., Wells, G.A., Tugwell, P., Kenny, G.P., Reid, R., ... & Coyle, D. (2012). Ottawa panel evidence-based clinical practice guidelines for aerobic walking programs in the management of osteoarthritis. *Archives of physical medicine and rehabilitation*, *93*(7), 1269-1285.
48. De Angelis, G. (2012). *The cost-effectiveness of an adapted community-based aerobic walking program for individuals with mild or moderate osteoarthritis of the knee*. University of Ottawa (Canada).