CHODKOWSKI, Jakub, GRABOWSKI, Filip and RULEWSKA, Natalia. The Influence of Physical Activity on The Development of Osteoarthritis: A Review. Quality in Sport. 2024;34:56206 eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.34.56206
https://apcz.umk.pl/QS/article/view/56206

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assig589 ned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 15.11.2024. Revised: 20.11.2024. Accepted: 27.11.2024. Published: 27.11.2024.

The Influence of Physical Activity on The Development of Osteoarthritis: A Review

Jakub Chodkowski
Specialist Regional Hospital in Ciechanów,
Powstańców Wielkopolskich 2, 06-400 Ciechanów, Poland
ORCID: 0009-0006-7097-4435
e-mail: jachodkowski@gmail.com

Filip Grabowski
Specialist Regional Hospital in Ciechanów,
Powstańców Wielkopolskich 2, 06-400 Ciechanów, Poland
ORCID: 0009-0007-0466-2764
e-mail: filipgrabowski52@tlen.pl

Natalia Rulewska
Specialist Regional Hospital in Ciechanów,
Powstańców Wielkopolskich 2, 06-400 Ciechanów, Poland
ORCID: 0009-0008-4515-7403
e-mail: nataliarulewska@gmail.com

ABSTRACT

Introduction: Osteoarthritis (OA) is a prevalent degenerative joint disease, primarily affecting the elderly, with substantial impacts on mobility and quality of life. This review explores the role of physical activity in the development and progression of OA, analyzing both protective and adverse effects.

Materials and Methods: A comprehensive literature review was conducted, analyzing studies from databases such as Google Scholar and PubMed on the effects of physical activity on OA. Analysis included longitudinal, cross-sectional, and interventional studies examining associations between physical activity levels, types of exercise, and OA onset and progression.

Results: Moderate, low-impact physical activity, including walking, swimming, and cycling, tends to have a protective effect on joint health by promoting muscle strength and cartilage resilience. However, high-impact or excessive repetitive activities, such as intense running or heavy weightlifting, are associated with a higher risk of OA, particularly in weight-bearing joints like the knees and hips. Moreover, individual factors, such as age, BMI, and previous joint injuries, significantly mediate the impact of physical activity on OA risk

Conclusions: Physical activity is a double-edged sword for OA; while moderate exercise may protect joint integrity, excessive high-impact activities may exacerbate OA risk, especially in predisposed individuals. Tailored exercise recommendations based on individual risk profiles could optimize benefits while minimizing OA development. Further research is needed to clarify dose-response relationships and to develop guidelines that balance the benefits of physical activity with OA prevention.

Keywords: osteoarthritis, physical activity, exercise, risk factors

INTRODUCTION

Osteoarthritis (OA) is one of the most common chronic joint disorders worldwide, characterized by the progressive degeneration of articular cartilage, subchondral bone remodeling, and inflammation of the synovial membrane. Affecting millions globally, OA presents a substantial burden on quality of life and healthcare systems due to pain, joint stiffness, and decreased mobility, particularly among older adults [1,2]. The knee, hip, and hand joints are most affected, although OA can develop in almost any joint in the body. Given the prevalence and impact of OA, understanding its risk factors and potential prevention strategies is critical.

Physical activity, generally celebrated for its broad health benefits, has a complex relationship with OA. Regular physical activity promotes cardiovascular health, improves muscle strength, enhances flexibility, and contributes to overall well-being [3]. However, the role of physical activity in the onset and progression of OA remains a matter of ongoing research and debate. Evidence suggests that while moderate, low-impact physical activities, such as walking and swimming, may support joint health, high-impact or excessive repetitive activities, such as running or heavy lifting, may increase OA risk in weight-bearing joints [4].

This complexity arises partly because the effects of physical activity on joints are influenced by various factors, including the intensity, frequency, and type of exercise, as well as individual characteristics like age, body mass index (BMI), and history of joint injury [5]. For

example, high-impact activities may induce mechanical stress on the joints, accelerating cartilage degradation in predisposed individuals [6].
Conversely, regular, moderate physical activity has been shown to enhance cartilage resilience and reduce inflammation, potentially offering a protective effect against OA development [7].
Therefore, this review aims to synthesize current knowledge on the role of physical activity in the development and progression of OA. By examining recent studies on physical activity's positive and negative impacts on joint health, this review seeks to clarify how exercise might be optimized to minimize OA risk. Understanding these relationships can inform recommendations on physical activity that support joint health while avoiding adverse outcomes, ultimately contributing to effective OA prevention and management strategies.

MATERIALS AND METHODS:

A comprehensive literature search was conducted across multiple databases, including PubMed, Scopus and Google Scholar, for studies published between 2000 and 2023. Keywords such as "osteoarthritis," "physical activity," "exercise," "joint health," and "risk factors" were used to identify relevant studies. Analysis included longitudinal, cross-sectional, and interventional studies examining associations between physical activity levels, types of exercise, and OA onset and progression. Additional articles were sourced through reference lists of selected studies to capture any potentially relevant studies missed by the initial search.

RESULTS:

Findings on the relationship between physical activity and osteoarthritis (OA) development varied based on the type, intensity, and duration of physical activity as well as individual factors such as age, BMI, and prior joint injuries. The key results are summarized below.

Moderate Physical Activity:

Numerous studies indicate that moderate physical activity can be beneficial for joint health and may lower the risk of developing OA, particularly in populations without advanced disease or pre-existing joint injuries [8]. For example, a cohort study by White et al. demonstrated that older adults engaging in regular moderate physical activity, such as walking and cycling, had a reduced risk of knee OA compared to those with a sedentary lifestyle. This study emphasized that moderate exercise could help maintain cartilage integrity and reduce stiffness, which are both important for OA prevention [9].
Other studies corroborate that moderate, low-impact exercise is generally safe and potentially protective against OA. In a large-scale prospective study, Dunlop et al. found that moderate-intensity physical activity helped reduce OA-related disability in older adults, enhancing functional independence and joint mobility [10]. This suggests that incorporating regular, moderate activity into daily routines could be beneficial for joint health.
Furthermore, a systematic review by Fransen et al. highlighted that moderate aerobic activities like swimming and light resistance exercises do not exacerbate knee OA and are associated with improved pain management and enhanced physical function in patients with mild to moderate OA [11]. These findings support the notion that moderate physical activity,

when well-regulated, does not pose significant OA risks and can, in fact, serve as a key factor in OA prevention strategies.

Lastly, a randomized controlled trial conducted by Messier et al. on adults with knee OA showed that moderate exercise, particularly when combined with weight management, improved joint function and reduced pain over a long-term follow-up, further highlighting the protective effects of regular, moderate activity on joint health [12].

High-Impact Activities:

A substantial body of evidence indicates that high-impact physical activities, such as running, jumping, competitive sports, and weightlifting, are associated with an increased risk of developing osteoarthritis (OA), particularly in weight-bearing joints like the knees and hips. This increased risk is primarily due to repetitive stress and mechanical loading on the joints, which can accelerate cartilage wear and degeneration.

Several studies highlight that high-impact sports, especially those involving intense or prolonged joint loading, are significant risk factors for OA. For instance, a cohort study by Hootman et al. examined former college athletes and found that individuals participating in high-impact sports had a higher incidence of knee OA compared to those who had a less physically demanding lifestyle [13]. This study provided early evidence that repeated joint loading and impact stress could contribute to joint degradation and OA development.

Similarly, a different study conducted a longitudinal analysis on long-distance runners and found that the cumulative effect of high mileage over years significantly increased knee OA risk, particularly among runners with other risk factors, such as a history of joint injuries or high BMI [14]. These findings are consistent with other research indicating that while moderate exercise may be safe, high-mileage running and similar high-impact activities elevate OA risk due to the repetitive stress applied to cartilage and surrounding joint tissues.

Research focusing on professional athletes has further demonstrated that high-impact sports participation is closely associated with elevated OA prevalence. For example, Vannini et al. reviewed OA prevalence in former elite soccer players and found that rates of knee and hip OA were substantially higher than in the general population. The study attributed these rates to the high frequency of pivoting, sprinting, and tackling required in soccer, which impose heavy demands on joint stability and resilience [15].

There is also substantial evidence linking repetitive weightlifting to OA development, particularly in the hips and knees. Kong et al. conducted a systematic review and found that powerlifters and competitive weightlifters had higher-than-average rates of OA, particularly in their lower extremities, attributed to the heavy loading required in these sports. The repetitive stress and extreme forces placed on the joints during weightlifting likely accelerate cartilage breakdown, particularly if not counterbalanced by sufficient recovery and conditioning [16].

The effect of high-impact activities on OA risk is further amplified in individuals with certain risk factors, such as high BMI and previous joint injuries. Blagojevic et al. reported that individuals with higher BMI who participated in high-impact sports were at a particularly elevated risk for knee OA, given the added load that BMI places on weight-bearing joints.

Similarly, Kessler et al. found that individuals with a history of anterior cruciate ligament (ACL) injuries experienced significantly higher rates of knee OA when participating in high-impact sports after recovery, suggesting that joint injuries compromise the joint's ability to withstand repetitive loading safely [5,17]

Another perspective was provided by a study on military personnel, who are often exposed to repetitive high-impact training and exercise. Cameron et al. examined rates of OA among military service members and found a significantly higher prevalence of knee and hip OA compared to the general population. This study highlighted that military training, which often involves running with heavy loads, jumping, and carrying weights, substantially increases the risk of OA due to the mechanical stress imposed on the joints [18].
While high-impact activities are beneficial for cardiovascular and muscular health, their potential to increase OA risk necessitates a balanced approach, particularly for individuals with predispositions to joint issues. The cumulative evidence suggests that those involved in high-impact sports or professions that require heavy loading on joints should consider preventive measures such as strength training, joint-stabilizing exercises, and adequate recovery time to mitigate OA risks.

Individual Factors in OA Risk:
Several studies demonstrated that individual factors like age, BMI, and prior joint injuries significantly modify the risk of OA associated with physical activity. Blagojevic et al. and Coggon et al. highlighted that individual with high BMI experienced a notably higher risk of knee OA when engaged in high-impact activities, likely due to the increased mechanical stress on weight-bearing joints [5, 19]. Age also emerged as a critical factor, with older adults experiencing greater vulnerability to OA when performing high-impact activities. Zhang and Jordan reported that individuals aged 60 and above were more susceptible to knee OA from intense physical activity, likely due to age-related cartilage degeneration and reduced joint resilience [20].
In addition, studies indicate that prior joint injuries, particularly ligament or meniscal tears, are associated with increased OA risk when engaging in strenuous physical activity. For instance, Kessler et al. found that individuals with a history of anterior cruciate ligament (ACL) injuries had higher rates of OA in later years if they participated in high-impact sports post-recovery [17]. These findings underscore the need to consider injury history when recommending physical activity levels.

Summary:
In summary, moderate physical activity is beneficial and may reduce OA risk, while high-impact or excessive physical activity elevates OA risk, especially in those with high BMI, advanced age, or a history of joint injury. These findings indicate the importance of personalizing physical activity recommendations based on individual risk factors to balance joint health benefits with OA prevention.

DISCUSSION

The relationship between physical activity and the development of osteoarthritis (OA) is complex and highly dependent on factors such as activity type, intensity, individual biomechanics, and pre-existing risk factors. This review aimed to summarize current evidence on how physical activity influences OA risk, with a focus on contrasting effects of moderate versus high-impact exercise.

Moderate, low-impact physical activities, such as walking, swimming, and cycling, appear to offer protective benefits against OA, as they help maintain joint health without imposing excessive mechanical load on cartilage. Research by White et al. found that moderate physical activity in older adults helped preserve cartilage integrity and reduce knee stiffness, which can mitigate OA risk in the absence of excessive load or trauma. Regular low-impact exercise may also enhance muscle strength around the joints, improve joint alignment, and contribute to healthy joint function over time [9].

Other studies have shown that moderate physical activity may benefit individuals with early-stage OA by reducing pain and improving function. A systematic review by Fransen et al. indicated that structured exercise, even at moderate intensity, can reduce pain and disability in OA patients without exacerbating the disease [11]. Such findings support the recommendation for moderate activity as part of both OA prevention and management strategies, highlighting its role in maintaining joint health and potentially delaying disease onset.

In contrast, high-impact activities such as running, high-intensity sports, and weightlifting are generally associated with a higher OA risk, particularly in weight-bearing joints like the knees and hips. Studies consistently report that repetitive joint loading during high-impact activities accelerates cartilage degeneration. Hootman et al. demonstrated that former college athletes who engaged in high-impact sports were at a significantly higher risk of developing knee OA, likely due to chronic mechanical stress on their joints [13].

Furthermore, Burfield et al. emphasized that long-distance running and similar repetitive high-impact activities can increase knee OA risk, especially in individuals with other risk factors like high BMI or previous joint injuries. Their findings suggest that cumulative exposure to joint stress - rather than isolated events - contributes to cartilage wear and, ultimately, OA development [14]. This effect is further supported by studies on professional athletes in sports like soccer and basketball, where OA prevalence is elevated due to the repetitive strain on joints from running, pivoting, and jumping [15].

The risk of OA associated with physical activity is influenced by individual factors such as BMI, age, and prior injuries, which can exacerbate the impact of high-intensity exercise. Blagojevic et al. found that people with higher BMI are particularly susceptible to OA when engaged in high-impact activities, as their joints are subject to greater mechanical loads. This finding highlights the importance of considering body weight when recommending activity levels, as weight management may mitigate OA risk even in high-impact sports [5].

Likewise, previous joint injuries, particularly ligament and meniscal injuries, have been identified as key risk factors that increase OA susceptibility during high-impact activities. Kessler et al. observed that individuals with a history of ACL injuries experienced significantly higher rates of OA when participating in intense sports post-recovery. This

suggests that injury history compromises joint stability and can predispose individuals to cartilage degeneration with continued joint loading [17].

CONCLUSIONS

The findings in this review indicate that personalized exercise recommendations based on an individual's risk profile may be essential for reducing OA risk. Moderate, low-impact exercises appear broadly beneficial for joint health and are generally safe for most individuals, including those with mild OA.

For high-impact activities, however, caution is advised - particularly for individuals with predisposing factors like high BMI or joint injuries. Integrating strength training and flexibility exercises may help improve joint resilience, while adequate recovery time can further mitigate the mechanical stress associated with high-impact sports.

In summary, while moderate physical activity is generally beneficial and may reduce OA risk, high-impact or excessive activity levels are linked to higher OA risk, especially in susceptible individuals. Clinicians should consider advising patients with higher OA risk to focus on activities that promote joint function without excessive loading. Personalized recommendations that account for individual risk factors and emphasize low-impact exercises can help optimize joint health and reduce OA incidence.

Author`s contribution:

Conceptualization: Jakub Chodkowski, Filip Grabowski
Methodology: Jakub Chodkowski, Natalia Rulewska
Software: Jakub Chodkowski, Natalia Rulewska
Check: Natalia Rulewska, Filip Grabowski
Formal analysis: Jakub Chodkowski, Filip Grabowski
Investigation: Jakub Chodkowski
Resources: Jakub Chodkowski, Natalia Rulewska
Data curation: Jakub Chodkowski
Writing-rough preparation: Jakub Chodkowski
Writing-review and editing: Jakub Chodkowski, Natalia Rulewska
Supervision: Jakub Chodkowski, Filip Grabowski
Project administration: Jakub Chodkowski

All authors have read and agreed with the published version of the manuscript.

Founding Statement:

The study did not receive funding.

Institutional Review Board Statement:

Not applicable.

Informed Consent Statement:

Not applicable.

Data Availability Statement:
Not applicable.

Conflict of Interest Statement:
The authors declare no conflicts of interest.

Acknowledgments:
Not applicable.

References:

1. Felson DT. Osteoarthritis as a disease of mechanics. Osteoarthritis Cartilage. 2013 Jan;21(1):10-5. doi: 10.1016/j.joca.2012.09.012. Epub 2012 Oct 4. PMID: 23041436; PMCID: PMC3538894.
2. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019 Apr 27;393(10182):1745-1759. doi: 10.1016/S0140-6736(19)30417-9. PMID: 31034380.
3. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. CMAJ. 2006 Mar 14;174(6):801-9. doi: 10.1503/cmaj.051351. PMID: 16534088; PMCID: PMC1402378.
4. Roos EM, Arden NK. Strategies for the prevention of knee osteoarthritis. Nat Rev Rheumatol. 2016 Feb;12(2):92-101. doi: 10.1038/nrrheum.2015.135. Epub 2015 Oct 6. PMID: 26439406.
5. Blagojevic M, Jinks C, Jeffery A, Jordan KP. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. Osteoarthritis Cartilage. 2010 Jan;18(1):24-33. doi: 10.1016/j.joca.2009.08.010. Epub 2009 Sep 2. PMID: 19751691.
6. Misra D, Fielding RA, Felson DT, Niu J, Brown C, Nevitt M, Lewis CE, Torner J, Neogi T; MOST study. Risk of Knee Osteoarthritis With Obesity, Sarcopenic Obesity, and Sarcopenia. Arthritis Rheumatol. 2019 Feb;71(2):232-237. doi: 10.1002/art.40692. Epub 2019 Jan 4. PMID: 30106249; PMCID: PMC6374038
7. Vignon E, Valat JP, Rossignol M, Avouac B, Rozenberg S, Thoumie P, Avouac J, Nordin M, Hilliquin P. Osteoarthritis of the knee and hip and activity: a systematic international review and synthesis (OASIS). Joint Bone Spine. 2006 Jul;73(4):442-55. doi: 10.1016/j.jbspin.2006.03.001. Epub 2006 May 6. PMID: 16777458.
8. Kraus VB, Sprow K, Powell KE, Buchner D, Bloodgood B, Piercy K, George SM, Kraus WE; 2018 PHYSICAL ACTIVITY GUIDELINES ADVISORY COMMITTEE*. Effects of Physical Activity in Knee and Hip Osteoarthritis: A Systematic Umbrella Review. Med Sci Sports Exerc. 2019 Jun;51(6):1324-1339. doi: 10.1249/MSS.0000000000001944. PMID: 31095089; PMCID: PMC6527143.
9. White DK, Lee J, Song J, Chang RW, Dunlop D. Potential Functional Benefit From Light Intensity Physical Activity in Knee Osteoarthritis. Am J Prev Med. 2017 Nov;53(5):689-696. doi: 10.1016/j.amepre.2017.07.008. Epub 2017 Aug 30. PMID: 28869091; PMCID: PMC5650918.

10. Dunlop DD, Song J, Semanik PA, Sharma L, Chang RW. Physical activity levels and functional performance in the osteoarthritis initiative: a graded relationship. Arthritis Rheum. 2011 Jan;63(1):127-36. doi: 10.1002/art.27760. PMID: 20862681; PMCID: PMC3010474.
11. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med. 2015 Dec;49(24):1554-7. doi: 10.1136/bjsports-2015-095424. Epub 2015 Sep 24. PMID: 26405113.
12. Messier SP, Mihalko SL, Legault C, Miller GD, Nicklas BJ, DeVita P, Beavers DP, Hunter DJ, Lyles MF, Eckstein F, Williamson JD, Carr JJ, Guermazi A, Loeser RF. Effects of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis: the IDEA randomized clinical trial. JAMA. 2013 Sep 25;310(12):1263-73. doi: 10.1001/jama.2013.277669. PMID: 24065013; PMCID: PMC4450354.
13. Hootman JM, Macera CA, Ainsworth BE, Addy CL, Martin M, Blair SN. Epidemiology of musculoskeletal injuries among sedentary and physically active adults. Med Sci Sports Exerc. 2002 May;34(5):838-44. doi: 10.1097/00005768-200205000-00017. Erratum in: Med Sci Sports Exerc. 2003 Jan;35(1):183. PMID: 11984303.
14. Burfield M, Sayers M, Buhmann R. The association between running volume and knee osteoarthritis prevalence: A systematic review and meta-analysis. Phys Ther Sport. 2023 May;61:1-10. doi: 10.1016/j.ptsp.2023.02.003. Epub 2023 Feb 13. PMID: 36809693.
15. Vannini F, Spalding T, Andriolo L, Berruto M, Denti M, Espregueira-Mendes J, Menetrey J, Peretti GM, Seil R, Filardo G. Sport and early osteoarthritis: the role of sport in aetiology, progression and treatment of knee osteoarthritis. Knee Surg Sports Traumatol Arthrosc. 2016 Jun;24(6):1786-96. doi: 10.1007/s00167-016-4090-5. Epub 2016 Apr 4. PMID: 27043343.
16. Kong H, Wang XQ, Zhang XA. Exercise for Osteoarthritis: A Literature Review of Pathology and Mechanism. Front Aging Neurosci. 2022 May 3;14:854026. doi: 10.3389/fnagi.2022.854026. PMID: 35592699; PMCID: PMC9110817.
17. Kessler MA, Behrend H, Henz S, Stutz G, Rukavina A, Kuster MS. Function, osteoarthritis and activity after ACL-rupture: 11 years follow-up results of conservative versus reconstructive treatment. Knee Surg Sports Traumatol Arthrosc. 2008 May;16(5):442-8. doi: 10.1007/s00167-008-0498-x. PMID: 18292988.
18. Cameron KL, Driban JB, Svoboda SJ. Osteoarthritis and the Tactical Athlete: A Systematic Review. J Athl Train. 2016 Nov;51(11):952-961. doi: 10.4085/1062-6050-51.5.03. Epub 2016 Apr 26. PMID: 27115044; PMCID: PMC5224737.
19. Coggon D, Reading I, Croft P, McLaren M, Barrett D, Cooper C. Knee osteoarthritis and obesity. Int J Obes Relat Metab Disord. 2001 May;25(5):622-7. doi: 10.1038/sj.ijo.0801585. PMID: 11360143.

20. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. Clin Geriatr Med. 2010 Aug;26(3):355-69. doi: 10.1016/j.cger.2010.03.001. Erratum in: Clin Geriatr Med. 2013 May;29(2):ix. PMID: 20699159; PMCID: PMC2920533.