Journal of Public Health and Pharmacy
2775-4952 (Online - Elektronik)

Research Articles Open Access

Occupational Risk of Knee Osteoarthritis Among Pedicab Operators: A Cross-Sectional Study in Indonesia

Rudiansyah Harahap[1]*, Muhammad Riza Setiawan[2], Lukman Faishal Fatharani[3], Hayyin Assofa Amina Putri[4]
[1]Department of Orthopedic and Traumatology, Faculty of Medicine, Universitas Muhammadiyah Semarang, Jawa Tengah, Indonesia
[2]Department of Occupational Health, Faculty of Medicine, Universitas Muhammadiyah Semarang, Jawa Tengah, Indonesia
[3]Department of Biomedical Sciences, Faculty of Medicine, Universitas Muhammadiyah Semarang, Jawa Tengah, Indonesia
[4]Faculty of Medicine, Universitas Muhammadiyah Semarang, Jawa Tengah, Indonesia

***Corresponding Author**: E-mail: rudiharahap2016@gmail.com

ARTICLE INFO

Manuscript Received: 27 Sept, 2024
Revised: 01 Jan, 2025
Accepted: 05 Feb, 2025
Date of publication: 02 Oct, 2025
Volume: 5
Issue: 3
DOI: 10.56338/jphp.v5i3.6734

KEYWORDS

Biomechanical;
Knee Pain;
Work Posture;
Pedicab Operators

ABSTRACT

Introduction: Osteoarthritis is a joint disease with multifactorial causes, particularly among pedicab operators. Movements such as pushing, pedaling, and lifting often cause damage to cartilage, ligaments, and synovial tissues. This study evaluates the risk of knee OA (Osteoarthritis) from the perspective of pedicab operators, a profession whose health is often neglected, by assessing work duration, length of work, footwear usage, and work posture.
Methods: This cross-sectional study was carried out on 50 pedicab operators based on inclusion and exclusion criteria. The demographic questionnaire used to assess work duration, length of work, footwear usage, and type of road. The posture was evaluated using the REBA Worksheet by measuring the angles of the neck, legs, body, wrists, upper arms, and lower arms. The risk of developing knee osteoarthritis was assessed using KOOS questionnaire. The data obtained was analyzed using SPSS version 26 and Graphpad.
Results: 48.3% are aged 45–50 years, with 69% having a work posture with a moderate risk level. 51.7% of pedicab operators were at risk for Knee OA. Data analysis found that there was a relationship between work posture (p = 0.01) and length of work (0.000) with the risk of OA, and there is a significant difference between OA scores for those wearing sandals compared to shoes.
Conclusion: The pedicab drivres have a risk of developing knee osteoarthritis through their length of work, footwear and work posture. This study stands out due to its biomechanical assessment, providing a detailed analysis of the factors contributing to the risk. The practical implications of this research underscore the importance of incorporating these findings into occupational health policies to enhance the well-being of pedicab operators and mitigate the risk of work-related musculoskeletal disorders. Furthermore, the study contributes to the broader discourse on occupational health, highlighting the need for targeted interventions and policy changes to protect workers in physically demanding jobs.

Publisher: Pusat Pengembangan Teknologi Informasi dan Jurnal Universitas Muhammadiyah Palu

INTRODUCTION

Knee osteoarthritis is an abnormal condition of the knee caused by a variety of factors, including trauma, inflammation, and metabolic abnormalities, biomechanical reactions and mechanical forces (1,2). In knee osteoarthritis, there are long-lasting alterations to the cartilage, muscles, ligments, and synovial tissue (3). This is due to the overreaction of the muscles in the knee creating compression, particularly in the tibio-femural joint (4). While knee osteoarthritis is typically linked with aging, there have been limited studies on the risk of knee osteoarthritis among pedicab operators (5).

Osteoarthritis is one of the joint disorders that is often experienced by adults and the elderly. The prevalence of osteoarthritis is 10-15%, with 3.3% men and 16% women (6,7). A study showed the topographic distribution of osteoarthritis joints, including 100% in the genue, 49% in the spine, and 13.2% in the metacarpophalangeal joints (4).

Many risk factors are often associated with increased incidence of osteoarthritis genue. Basically, risk factors for osteoarthritis genue are caused by systemic factors and local factors (8). Age, gender, race, genetics, and congenital abnormalities are systemic factors, while obesity, history of injury, occupation, and physical activity are local factors (9).

One of the factors that increases the incidence of occupational osteoarthritis is carrying out heavy work activities (10). Heavy work can cause biomechanical stress such as bending the knees, standing for long periods, and squatting for long periods (more than 2 hours per day) (11). Osteoarthritis of the hip is also associated with repeated heavy physical activity; although the process of OA hip is not yet clear, OA hip due to heavy physical activity is associated with several mechanisms (12). Inflammation of the joints is the main process due to high stress on the joint area, including on the ligaments, muscles, and cartilage (1).

Pedicab pedaling involves diverse physical tasks and is a popular mode of transportation in Indonesia (13). Pedicab peddlers frequently encounter postural challenges like lifting, transporting, pushing, and pedaling, which can heighten the risk of osteoarthritis (14,15). Some studies have shown that frequent extension of the lower extremities is closely related to the emergence of OA genue complaints for 1.5 to 8 years, and other studies have also shown that thigh strength can increase the risk of OA genue (8,16). However, several previous studies related to informal workers in Indonesia have never studied among pedicab operators, and this job is one whose health is often neglected. This study seeks to assess the likelihood of developing osteoarthritis in the knee joints of pedicab operators by analyzing their posture during work, individual characteristics such as length of work and work duration, as well as work factors such as footwear used and the type of road traveled.

METHOD

This study used a quantitative study with A cross-sectional approach. A Total sampling recruited 50 pedicab operators who were willing to be respondents. Pedicab operators who had complaints of pain other than the knee, had a history of trauma or injury to the knee, were experiencing infection or inflammation of the knee, had deformities in the lower extremities, were obese, and had other jobs besides pedicab operators would be excluded.

This study was conducted in Menara Kudus, Kudus City, Centra Java, Indonesia, which is an area with diverse cultures, making it one of the most visited places and has a diverse community, one of which is the pedicab operators community.

Data collection used standard questionnaires, namely the REBA questionnaire and the KOOS questionnaire. The REBA questionnaire is useful in assessing forced work postures. The use of REBA begins with taking pictures of pedicab operators while working, then measuring the angle. Angle measurement consists of six assessment components, including the back (torso), neck movement, leg movement, upper arm movement, lower arm movement, and wrist movement. The results obtained will be adjusted to the REBA assessment sheet and categorized into 5 levels, namely, a score of 0 means it can be ignored, a score of 2-3 is low risk, a score of 4-7 is moderate risk, 8-10 is high risk, and a score of 11-15 is very high risk.

We also used the KOOS questionnaire to document clinical changes after knee injury. This questionnaire aims to examine long-term examination of knee injuries and the perception of trishaw drivers regarding their knee problems. Measurements are made based on five dimensions on a Likert scale: pain (9 questions); symptoms (7 questions); activity of daily living (17 questions); sport and recreation function (5 questions); knee-related quality of life (4 questions). Scores range from 0 to 100, where 0 indicates severe problems and 100 signifies no issues. In the demographic questionnaire we also assessed the work duration, length of working, footwear usage and the type of roads traveled by pedicab operators. The use of footwear consists of wearing sandals or shoes, and the road traveled is flat or unflat road. Both questionnaires have undergone validity and reliability tests, with the ICC value for the REBA questionnaire being 0.925 and the KOOS questionnaire ranging between 0.79-0.97 (17,18).

The risk of knee OA was presented on a nominal and ratio scale, while body posture was presented on an ordinal and ratio scale. We used the chi-square test to assess the relationship between the two, and we also analyzed using the odd ratio of both. We also analyzed using linear regression through the scores we got from the KOOS questionnaire and the REBA Score. For the work duration and length of working, we present them in ratios and nominal scale, while the footwear usage and the type of road traveled are presented in nominal form. We used t-test to asses the differences in each category. We analyzed using GraphPad version 9.5 and SPSS version 24.

Ethical Consideration

This study was approved by Ethics Committee of Universitas Muhammadiyah Semarang (Approval Number: 078/EC/KEPK-FK/UNIMUS/2022), and all participants have signed informed consent.

RESULTS

The findings revealed that a significant portion of the respondents were pedicab operators aged 45-50 years (48.3%). Approximately 51.7% of the respondents were identified to be at risk of knee osteoarthritis (OA), while the majority exhibited bad posture while working (69%). The average respondent worked 12.1 hours with an average of 22.64 years as a pedicab driver. Table 1 presents the detailed characteristics of our study participants.

Table 1. Distribution of Respondents

Characteristics	N (%)	Mean (±SD)
Age (years old)		
30-34	5 (17.2%)	
35-44	10 (34.5%)	
45-50	14 (48.3%)	
Work duration (hours)	-	12.1 (±1.29)
Length of work (years)	-	22.64 (±9.51)
Body Posture		
Extremely Bad	0 (0%)	
Very Bad	9 (31%)	
Bad	20 (69%)	
Average	0 (0%)	
Good	0 (0%)	
Footwear		
Sandals	41 (82%)	
Shoes	9 (18%)	
Knee OA Risk		
Yes	15 (51.7%)	
No	14 (48.3%)	

Source: Primary Data

Figure 1. Assessment of Work Posture

After collecting the data, we analyzed the relationship between the work duration, length of work, footware usage, type of road traveled, body posture with the risk of knee osteoarthritis (OA). We categorized the work duration and length of work into two categories by finding the average and classifying them as above average and below average. The analysis results showed a relationship between length of work (cOR 4.39, p=0.000) and body posture (cOR 7.05, p=0.018). We analyzed using linear regression tests which also showed a correlation between work posture (p=0.003; R^2=0.165) and length of work (p=0.000; R^2=0.245) with OA risk score. However, we also conducted a t-test for footware usage and type of road travelled. We found that the OA risk scores are significantly higher when wearing sandals compared to shoes (p=0.018) although the analysis to assess the odds ratio showed no relationship. All results are presented in Table 2 and Figure 2.

Table 2. Association analysis of risk factors for knee OA

Risk factors	OA Risk		cOR(95%CI), p-value*
	Yes (%)	No (%)	
Work duration (hours)			0.059
>12	17 (73.9)	6 (26.1)	
≤12	15 (57.7)	11 (42.3)	
Length of work (years)			4.39(0.027;1.58), 0.000*
≥22.64	23 (92)	2 (8)	
<22.64	10 (40)	15 (60)	
Work posture			7.05(1.389;35.87), 0.018*
Very bad	16 (88.9)	2 (11.1)	
Bad	17 (53.1)	15 (46.9)	
Footwear			0.128
Sandals	28 (68.3)	13 (31.7)	
Shoes	5 (55.6)	4 (44.4)	
Type of road			0.420
Unflat Road	22 (61.1)	14 (38.9)	
Flat Road	11 (78.6)	3 (21.4)	

*p= significant

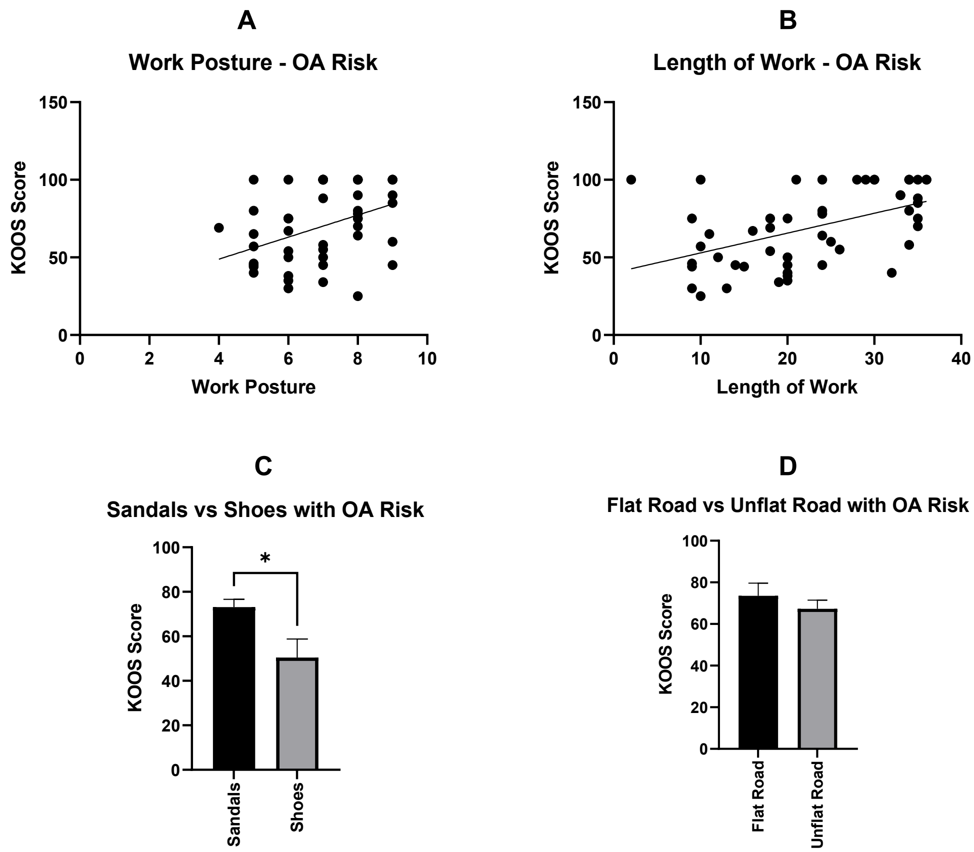

Figure 2. Statistical analysis results. A) analysis of work posture with OA risk; B) analysis of length of work with OA risk; C) analysis of uses of sandals vs shoes with OA risk, D) analysis of flat road vs unflat road with OA risk

To assess the strength of the relationships between these factors, we conducted an analysis after adjusting for other risk factors stated above. The results indicated that work posture is the factor most strongly associated with the risk of OA. Our analysis results are presented in Table 3

Table 3. Association analysis of risk factors of OA risk after adjusment

Risk factor	aOR(95%CI), p-value
Length of work	0.347
Work Posture	0.082(0.014;0.474), 0.005*

*p=significant

DISCUSSION

Interpretation of Key Findings and Comparison with Previous Studies

Based on the characteristics, it was found that there is a positive correlation between length of work with knee osteoarthritis (OA) risk. Prolonged length of work can cause stress on the spine (19). While working, pedicab operators often have to maintain a forward-bent position for extended periods. This can result in spinal injuries. This finding is consistent with previous research on batik workers, which showed that prolonged work duration and the tendency to bend the body while working increase the risk of developing low back pain (LBP) (20). The study results also show that wearing sandals is associated with the occurrence of LBP. Using thin footwear does not provide support for the muscles of the back of the foot. This will affect balance and stability, and lead to fatigue in the spine. Several studies indicate that improper footwear usage will increase the incidence of LBP (21,22).

This study demonstrated that pedicab operators are susceptible to knee osteoarthritis (OA). The heightened risk among pedicab peddlers is linked to posture, supported by statistically significant findings. The repetitive pedaling action strengthens the flexor and extensor muscles force around the knee, potentially leading to damage to tendons, ligaments, and other structures over time (23,24). This study aligns with a meta-analysis conducted by Hulshof et al., which indicated that ergonomic factors, including exertion during work, can elevate the risk of knee osteoarthritis (OA) (25). Another study by d'Errico similarly reported that factors such as static strength, trunk strength, awkward positions, and driving a vehicle can elevate the risk of osteoarthritis (OA). The study found correlation coefficients of 0.89 for static strength, 0.88 for trunk strength, 0.65 for awkward positions, and 0.60 for driving a vehicle.(26)

Cartilage in the knee joint has avascular characteristics and no pain fibers, but evidence suggests that knee joints such as synovium have a role in the emergence of knee pain. Inflammation is the initial process that triggers changes in synovial joint characteristics such as hyperplasia, fibrosis, angiogenesis and effusion (27). The release of inflammatory cytokines such as interleukins (IL)-6, IL-1β, and TNF-α plays a role in nociceptor activation and increasing C-reactive protein levels. This triggers increased pain in the OA genue (28).

In general, the occurrence of OA is based on four important points, namely factors that affect cartilage synthesis and degradation, an imbalance between the synthesis and degradation of the extracellular matrix, apoptosis in chondrocytes, and lesions in the subchondral. Cartilage degradation is closely associated with the presence of pro-inflammatory cytokines and pro-anabolic factors such as insulin-like growth factor 1 (IGF-1). Increased free radicals in the synovial cause inhibition of joint proliferation, increase apoptosis, and imbalance of the extracellular matrix (29,30).

Extracellular matrix is produced by chondrocytes containing various proteins to support joint function. Various studies have shown that cartilage disorders in the OA genue are caused by degeneration of the extracellular matrix. Extracellular matrix imbalance is associated with MAPKs, NF-kB, and Wnt/β-catenin signaling pathways. (31) Apoptosis in chondrocytes is actually normal, even though the amount is small and only certain parts, but excessive apoptosis is one of the factors that causes the emergence of OA genue. Several studies have shown that in cases of OA genus, apoptosis occurs. Apoptosis that occurs will cause death in receptors and stress on the endoplasmic reticulum (32).

Another aspect related to posture while pedaling a pedicab involves the bicycle saddle. The height of the saddle dictates the pedaling position, and when the saddle is too high, it can lead to reduced strength and muscle inefficiency due to increased muscle tension (10). This study corroborates findings from Plessan et al., which suggest that non-ergonomic saddle sizes can contribute to musculoskeletal pain. Other studies also indicate a correlation between work posture and musculoskeletal disorders (6,33,34). A study conducted on sedentary office workers shows that improper sitting posture can lead to the development of low back pain (35,36). Another study conducted on professional drivers also found that improper sitting posture while driving, combined with vibration, increases the incidence of low back pain (37).

In addition, pedicab operators also always do repetitive movements and cause overuse injuries. The position of the body when pedaling plays an important role in causing complaints in the knee. A lower saddle will increase the angle of the knee flexion movement when pedaling, and this causes damage to the tissue around the knee (38). Repetitive movements will also cause discomfort in the knees due to an imbalance between internal rotation and external rotation of the thighs and a decrease in the range of motion (ROM) of the abduction movement (39). Damage to the meniscus can also occur due to continuous flexion movements and compression, resulting in the cartilage in the joint experiencing degeneration that reaches the subchondral layer (40). Other analysis shows that knee complaints are caused by an imbalance from adduction to abduction movements due to weakness of the abduction muscle group. Previous research shows that a decrease in thigh muscle strength correlates with knee pain. When the muscles experience changes in their strength, the entire load will be transferred to the knee joint and cause complaints (41).

The emergence of osteoarthritis is also not only caused by an unergonomic position while working but can also be caused by the heavy load of passengers while working. Increased workloads coupled with the burden of tools as additional loads will increase the risk of osteoarthritis (42,43). Pressure and tension due to excessive loads such as carrying passengers and pedaling a pedicab will accelerate damage to the cartilage so that it will cause symptoms of pain, swelling, and decreased mobility. If this is repeated, it will cause chronic inflammation and worsen joint damage.(44,45)

Implication for Public Health

Our research has shown that there is a correlation between length of work, the use of sandals as footwear, and work posture with the risk of knee osteoarthritis (OA). These findings have significant implications for public health, particularly for informal workers. Environmental interventions are an appropriate step to reduce the risk of OA, such as ergonomic improvements at workplaces or on work tools. This can be related to comfortable working postures, such as adjusting the saddle on pedicab. Additionally, rehabilitation programs involving stretching exercises can play a part in maintaining joint health. Furthermore, the presence of specific health screening programs in communities with jobs at risk for OA is also very important. Regular health screenings help to detect early signs of knee OA, allowing for quicker interventions.

Limitations and Cautions

Although the results of this study indicate a correlation between length of work, work posture, footwear and the risk of osteoarthritis, this study has some limitations. The first is that this study has a small sample size and uses a cross-sectional study. For further research, we suggest that it is necessary to expand the number of samples and conduct longitudinal studies to assess the long-term development of osteoarthritis due to poor work posture. Another limitation is that this study has not assessed the severity of osteoarthritis through several supporting examinations such as x-rays or MRI, so the next suggestion is to conduct these examinations to validate the diagnosis of osteoarthritis.

Recommendation for Future Research

Recommendations for further research include conducting longitudinal studies that can provide a deeper understanding of length of work, footwear use and work posture with OA risk. The results of these studies will provide stronger scientific evidence to provide more effective policy and program recommendations for public health.

CONCLUSION

Our study revealed that pedicab operators are at risk of developing knee osteoarthritis (OA), and there is a significant relationship between length of work, footwear, and body posture with the risk of OA. These findings suggest that the results of this research can be used to advocate for changes in government labor regulations and policies. Implementing such regulations can help protect pedicab operators from the risk of developing OA and ensure their well-being while carrying out their work. This will not only improve their quality of life but also contribute to a healthier and more sustainable workforce in this sector.

AUTHOR’S CONTRIBUTION STATEMENT

Author 1: formulate concepts, design research methods, review data, validate data, review the writing
Author 2: analyzing in creating data visualizations, editing writing
Author 3: analyzing in creating data visualizations, editing writing
Author 4: design methods, collect data, validate data, editing writing

CONFLICTS OF INTEREST

The authors declared no conflict of interest.

SOURCE OF FUNDING STATEMENTS

This research was funded by Universitas Muhammadiyah Semarang.

ACKNOWLEDGMENTS

In addition to acknowledging the Universitas Muhammadiyah Semarang for financing this study, the researcher would like to acknowledge the pedicabs at Menara Kudus who took part in it.

BIBLIOGRAPHY

1. Berteau JP. Knee Pain from Osteoarthritis: Pathogenesis, Risk Factors, and Recent Evidence on Physical Therapy Interventions. J Clin Med. 2022;11(12).
2. Mora JC, Przkora R, Cruz-Almeida Y. Knee osteoarthritis: Pathophysiology and current treatment modalities. J Pain Res. 2018;11:2189–96.
3. Primorac D, Molnar V, Rod E, Jeleč Ž, Čukelj F, Matišić V, et al. Knee osteoarthritis: A review of pathogenesis and state-of-the-art non-operative therapeutic considerations. Genes (Basel). 2020;11(8):1–35.
4. Ghazwan A, Wilson C, Holt CA, Whatling GM. Knee osteoarthritis alters peri-articular knee muscle strategies during gait. PLoS One [Internet]. 2022;17(1 January):1–16. Available from: http://dx.doi.org/10.1371/journal.pone.0262798
5. Lespasio MJ, Piuzzi NS, Husni ME, Muschler GF, Guarino A, Mont MA. Knee Osteoarthritis: A Primer. Perm J. 2017;21:1–7.
6. Sharma R, Singh R. Work-related musculoskeletal disorders, job stressors and gender responses in foundry industry. Int J Occup Saf Ergon. 2014;20(2):363–73.
7. Seok H, Choi SJ, Yoon J ha, Song GG. The Association between Osteoarthritis and Occupational Clusters in the Korean Population : A Nationwide Study. PLoS One. 2017;1–10.
8. Roux CH, Ferrero S. Epidemiology of osteoarthritis. Rev du Rhum (Edition Fr. 2024;30(2):184–95.
9. Allen KD, Thoma LM, Golightly YM. Epidemiology of osteoarthritis. Osteoarthr Cartil. 2022;30(2):184–95.
10. Menard M, Domalain M, Decatoire A, Lacouture P. Influence of saddle setback on pedalling technique effectiveness in cycling. Sport Biomech. 2016;15(4):462–72.
11. Wang X, Perry TA, Arden N, Chen L, Parsons CM, Cooper C, et al. Occupational Risk in Knee Osteoarthritis: A Systematic Review and Meta-Analysis of Observational Studies. Arthritis Care Res. 2020;72(9):1213–23.
12. Driban JB, Hootman JM, Sitler MR, Harris KP, Cattano NM. Is participation in certain sports associated with knee osteoarthritis? A systematic review. J Athl Train. 2017;52(6):497–506.
13. Sugiharto H, Chandra NR, Legiran L. Prevalensi Nyeri Muskuloskeletal Pada Pengemudi Becak Kayuh Di Palembang. Sriwij J Med. 2020;3(1):15–23.
14. Mukaromah E, Suroto, Widjasena B. ANALISIS FAKTOR RISIKO GANGGUAN MUSKULOSKELETAL PADA PENGAYUH BECAK (STUDI KASUS DI PASAR PAGI KABUPATEN PEMALANG). Jurnal Kesehatan Masyarakat. 2016;5:1–23.
15. Singh A, Septadina I, Zulissetiana E. Body Mass Index and Working Period Associated with Low Back Pain in Pedicab Drivers. Heal Sci J Indones [Internet]. 2022;13(1 SE-Articles):26–31. Available from: http://ejournal2.bkpk.kemkes.go.id/index.php/hsji/article/view/6455
16. Allen DG, Whitehead NP, Froehner SC. Absence of dystrophin disrupts skeletal muscle signaling: Roles of Ca2+, reactive oxygen species, and nitric oxide in the development of muscular dystrophy. Physiol Rev [Internet]. 2015;96(1):253–305. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84949934042&doi=10.1152%2Fphysrev.00007.2015&partnerID=40&md5=601f4bba83bc7003d58d9d58d925e322
17. Schwartz AH, Albin TJ, Gerberich SG. Intra-rater and inter-rater reliability of the rapid entire body assessment (REBA) tool. Int J Ind Ergon [Internet]. 2019;71(January):111–6. Available from: https://doi.org/10.1016/j.ergon.2019.02.010
18. Roos EM, Toksvig-Larsen S. Knee injury and Osteoarthritis Outcome Score (KOOS) - Validation and comparison to the WOMAC in total knee replacement. Health Qual Life Outcomes. 2003;1:1–10.
19. Hendrika W, Sitompul YRM., Petrus G. The Relationship Between Sitting Attitude and Duration of Work with Low Back Pain Complaints Among Kalimantan Tengah Health Office Employees in 2019. J Drug Deliv Ther. 2022;12(6):164–70.
20. Pamungkas M, Pratama SB, Fatharani LF. Influence of Work Posture and Work Duration on the Incidence of Low Back Pain Among Batik Artisans: a Cross-sectional Study. Indones J Heal Sci Res Dev. 2024;6(1):240–7.
21. Shabrina G, Iqbal BM, Syaifullah DH. Effect of Shoes on Lower Extremity Pain and Low Back Pain during Prolonged Standing on a Sloping Medium. 2018 Int Conf Intell Informatics Biomed Sci ICIIBMS 2018. 2018;4(1):181–7.

22. Kong L, Zhou X, Huang Q, Zhu Q, Zheng Y, Tang C, et al. The effects of shoes and insoles for low back pain: a systematic review and meta-analysis of randomized controlled trials. Res Sport Med [Internet]. 2020;28(4):572–87. Available from: https://doi.org/10.1080/15438627.2020.1798238
23. Muraki S, Akune T, Teraguchi M, Kagotani R, Asai Y, Yoshida M, et al. Quadriceps muscle strength, radiographic knee osteoarthritis and knee pain: The ROAD study Epidemiology of musculoskeletal disorders. BMC Musculoskelet Disord [Internet]. 2015;16(1):1–10. Available from: http://dx.doi.org/10.1186/s12891-015-0737-5
24. Dahaghin S, Tehrani-Banihashemi SA, Faezi ST, Jamshidi AR, Davatchi F. Squatting, sitting on the floor, or cycling: Are life-long daily activities risk factors for clinical knee osteoarthritis? Stage III results of a community-based study. Arthritis Care Res. 2009;61(10):1337–42.
25. Hulshof CTJ, Pega F, Neupane S, Colosio C, Daams JG, Kc P, et al. The effect of occupational exposure to ergonomic risk factors on osteoarthritis of hip or knee and selected other musculoskeletal diseases: A systematic review and meta-analysis from the WHO/ILO Joint Estimates of the Work-related Burden of Disease and In. Environ Int. 2021;150:106349.
26. d'Errico A, Fontana D, Sebastiani G, Ardito C. Risk of symptomatic osteoarthritis associated with exposure to ergonomic factors at work in a nationwide Italian survey. Int Arch Occup Environ Health [Internet]. 2023;96(1):143–54. Available from: https://doi.org/10.1007/s00420-022-01912-1
27. Scanzello CR, Goldring SR. The role of synovitis in osteoarthritis pathogenesis. Bone [Internet]. 2012;51(2):249–57. Available from: http://dx.doi.org/10.1016/j.bone.2012.02.012
28. Zhang J. Meta-analysis of serum C-reactive protein and cartilage oligomeric matrix protein levels as biomarkers for clinical knee osteoarthritis. BMC Musculoskelet Disord. 2018;19(1):1–6.
29. Kim JR, Yoo JJ, Kim HA. Therapeutics in osteoarthritis based on an understanding of its molecular pathogenesis. Int J Mol Sci. 2018;19(3).
30. Wojdasiewicz P, Poniatowski ŁA, Szukiewicz D. The role of inflammatory and anti-inflammatory cytokines in the pathogenesis of osteoarthritis. Mediators Inflamm. 2014;2014.
31. Yao Q, Wu X, Tao C, Gong W, Chen M, Qu M, et al. Osteoarthritis: pathogenic signaling pathways and therapeutic targets. Signal Transduct Target Ther. 2023;8(1).
32. Ryu JH, Shin Y, Huh YH, Yang S, Chun CH, Chun JS. Hypoxia-inducible factor-2α regulates Fas-mediated chondrocyte apoptosis during osteoarthritic cartilage destruction. Cell Death Differ. 2012;19(3):440–50.
33. Plessas A, Bernardes Delgado M. The role of ergonomic saddle seats and magnification loupes in the prevention of musculoskeletal disorders. A systematic review. Int J Dent Hyg. 2018;16(4):430–40.
34. Hynd J, Cooley D, Graham M. Saddle tilt during uphill cycling improves perceived comfort levels, with corresponding effects on saddle pressure in highly trained cyclists. J Sci Cycl. 2017;6(3):36–8.
35. Bontrup C, Taylor WR, Fliesser M, Visscher R, Green T, Wippert PM, et al. Low back pain and its relationship with sitting behaviour among sedentary office workers. Appl Ergon [Internet]. 2019;81(January):102894. Available from: https://doi.org/10.1016/j.apergo.2019.102894
36. Fujitani R, Jiroumaru T, Noguchi S, Michio W, Ohnishi H, Suzuki M, et al. Effect of low back pain on the muscles controlling the sitting posture. J Phys Ther Sci. 2021;33(3):295–8.
37. Chen C, Xiao B, He X, Wu J, Li W, Yan M. Prevalence of low back pain in professional drivers: a meta-analysis. Public Health [Internet]. 2024;231:23–30. Available from: https://doi.org/10.1016/j.puhe.2024.03.007
38. Bini RR, Hume P. Effects of saddle height on knee forces of recreational cyclists with and without knee pain. International SportMed. Journal.2014;(July).
39. Cejudo A, Baranda PS De, Ayala F, Croix MDS, Santonja-medina F. Assessment of the Range of Movement of the Lower Limb in Sport : Advantages of the ROM-SPORT I Battery. Int J Enviromental Res Public Heal. 2020;17:1–26.
40. Timothy K. Obesity and osteoarthritis. Maturitas [Internet]. 2016; Available from: http://dx.doi.org/10.1016/j.maturitas.2016.04.006
41. Bobowik P, Agnieszczak M, Legut P, Wiszomirska I, Kaczmarczyk K. Overload knee joint pain in horse riding athletes. Acta Kinesiol. 2024;18(1):63–9.
42. Wu Y, Boer CG, Hofman A, Schiphof D, Middelkoop M Van, Szilagyi IA. Weight-Bearing Physical Activity , Lower-Limb Muscle Mass , and Risk of Knee Osteoarthritis. Orthopedics. 2024;7(4):1–11.

43. Cui A, Zhang J, Deng H, Wei X, Zhuang Y, Wang H. Weight change patterns across adulthood are associated with the risk of osteoarthritis : a population - based study. Aging Clin Exp Res [Internet]. 2024; Available from: https://doi.org/10.1007/s40520-024-02792-w
44. Danaei G, Andrews KG, Sudfeld CR, Fink G, McCoy DC, Peet E, et al. Risk Factors for Childhood Stunting in 137 Developing Countries: A Comparative Risk Assessment Analysis at Global, Regional, and Country Levels. PLoS Med. 2016;13(11).
45. Gignac MAM, Irvin E, Cullen K, Eerd D Van, Beaton DE, Mahood Q, et al. Men and Women ' s Occupational Activities and the Risk of Developing Osteoarthritis of the Knee , Hip , or Hands : A Systematic Review and Recommendations for Future. Arthritis Care & Research. 2019;72(3):378–96.