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Exploring the Effects of Retro Walking on Functional Outcomes in Knee Osteoarthritis: A Scoping Review

Alifia Azzahra Putri Satrio*[1], Farid Rahman[2]

[1]Affiliation : Department of Physiotherapy, Universitas Muhammadiyah Surakarta, Indonesia

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Abstract

Retro walking is a form of exercise that involves walking backwards as an alternative to forward walking. Previous studies highlighted its benefits in improving balance, coordination, and muscle strength, therefore improving functional ability of the lower extremities including the knee joints. This review aims to provide overview of the latest available studies regarding the impact of retro walking in patients with knee osteoarthritis. Studies that had been published until October 2023 in a peer-reviewed journal with the language limited to English and Indonesian were considered. The intervention was retro walking as an adjunct exercise program, and the outcome was aspects related to functional ability of the knee. After reviewing 20 included articles, it was found that the duration of retro walking exercise was generally given for 10 minutes per session for a total of about 70 minutes per week to patients with knee osteoarthritis 40 years old and over, with the exercise given using treadmill, with or without harness, or simply on the ground with cone with various distance and the patients' comfortable walking speed. The findings suggest that retro walking is effective as an adjunct to rehabilitation program for the improvement of aspects that may eventually help improve and maintain functional abilities of knee osteoarthritis patients.

*Corresponding email : j120231087@student.ums.ac.id
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INTRODUCTION

Knee osteoarthritis is a medical condition that commonly causes pain, stiffness, and limited movement in the knee joint that progressively worsens over time (Lespasio et al., 2017). The prevalence of knee osteoarthritis is around 16% in individuals aged 15 and older, with approximately 600 million people aged 40 and above (Cui et al., 2020). The condition not only compromises physical comfort but also quality of life, since everyday tasks become challenging. Knee osteoarthritis is generally caused by wear and tear, or damage from frequent use, to the cartilage that cushions the knee joint. Over time, this tissue deteriorates, creating friction between bones that results in pain and discomfort (Hsu & Siwiec, 2018). This condition is unable to be stopped or reversed, although therapy may help patients to ease their symptoms (Bhatia et al., 2013). In dealing with this challenge, an exercise program is essential to minimize symptoms and improve functional abilities in patients (Afifatuzzahra et al., 2023). One approach that is gaining popularity is retro walking.

Retro walking emerges as a potential approach in the area of physical rehabilitation for individuals with various gait impairments due to various injuries such as musculoskeletal or nervous. Many of the studies on retro walking has been done for treatment of knee osteoarthritis condition. Retro walking is a form of exercise that involves walking backwards on a treadmill or in a controlled environment while focusing on enhancing balance, strength, and mobility in the lower extremities and therefore improving gait patterns (Joshi et al., 2019). Retro walking can be provided in a safe exercise setting to facilitate patients to engage in rehabilitation activities focused on improving various aspects of the lower limb. The distinctive aspect of retro walking lies in its ability to imitate forward walking movement without doing exactly it, by replicating the movements relevant to walking forward but in a different sequence with altered biomechanics. Also, retro walking target different muscle groups and movement patterns compared to forward walking. This variation in movement can be beneficial for addressing muscular imbalances, enhancing coordination, and improving proprioception, ultimately leading to more comprehensive rehabilitation outcomes (Balasukumaran et al., 2020; Frye, 2001). Through repetitive and progressively challenging variations, retro walking sessions can help promote better learning and adaptability since it shares the same muscle synergy modules and control strategies with forward walking so it can be translated into forward walking on the daily. However, the most remarkable thing about retro walking for knee osteoarthritis is that it reduces stress on patellofemoral joint during the exercise so patients could exercise for a longer more ideal duration without the fear of knee pain getting in their way (Joshi et al., 2019; Shu et al., 2016). This retro walking approach offers a novel and effective means of addressing the limitations associated with knee osteoarthritis, ultimately leading to improved rehabilitation outcomes for affected individuals such as their ability to perform tasks that are essential for maintaining independence and quality of life. This scoping review aims to explore the benefits of retro walking exercise and how it can help as an adjunct in rehabilitation programs to help patients with knee osteoarthritis regain their functional ability.

METHODS

This scoping review aimed to survey and summarize the existing literature to

answer the following research question, 'what is known about retro walking exercise as an adjunct to knee osteoarthritis patients' rehabilitation program in improving functional ability?' which was developed as per the population, intervention, comparison, and outcome (PICO) model. This review followed the protocol for conducting scoping reviews according to the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) (Peters et al., 2015).

Search Strategy

Several electronic database were accessed in October 2023 for this review including CINAHL, ProQuest, Scopus, PubMed, and GoogleScholar, which were searched using the keywords [("knee osteoarthritis" OR "knee oa" OR "knee arthritis" OR "degenerative joint disease") AND (backward* walking OR walking backward* OR backward* locomotion OR retro walking OR retrowalking) AND ("quality of life" OR "life quality" OR "functional ability" OR "functional capacity" OR "mobility")]. The relevant studies were included if they were published up to 2023 in English or Indonesian. All types of quantitative study designs were included so long as these reported full text papers, with the intervention using retro walking as an adjunct to conventional therapy program for patients with knee osteoarthritis focusing on functional ability as the outcome.

Study Selection

Articles were selected by a process of title and abstract screening leading to full text review by two independent reviewers with inclusion by agreement. The articles were compared against the inclusion criteria and screened for significance, conflicts were discussed until agreement was reached between the reviewers. A reference software manager was used to assist the selection process. The details of the study selection process are shown in Figure 1.

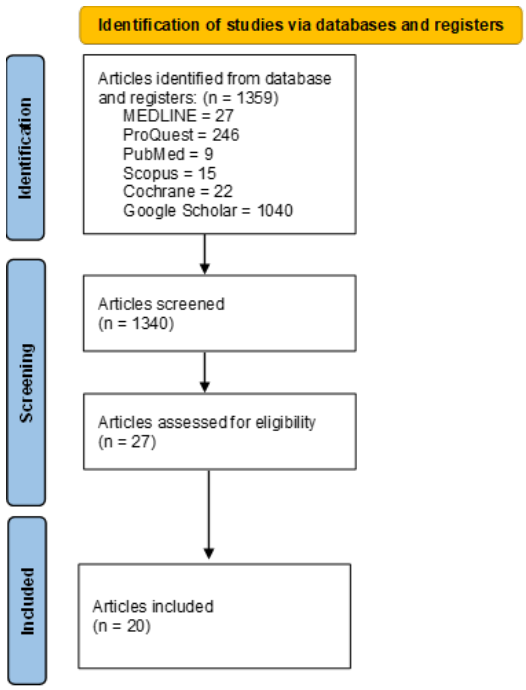

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses

Data Extraction and Synthesis

Once the articles meeting the criteria for inclusion in the review were chosen, the complete texts were downloaded and examined in depth. Data from each article were extracted into a table including author/publication details, study aims, population, intervention, and key findings relevant to the review question.

Assessment of the quality of research methodology of each article was carried out using assessment tools that have been recognized as appropriate for assessing certain types of methodologies: randomized controlled trial type using PEDro (Physiotherapy Evidence Database) assessment; quasi-experimental type using JBI (Joanna Brigs Institute); and case report type using CARE (Case

Report Guidelines) assessment. Furthermore, data synthesis from each article is carried out by collecting various information related to the provision of retrowalking interventions and discussing their effects on knee osteoarthritis patients on various aspects that helps functional ability, this is assisted by using the TIDIer checklist.

RESULT

The initial search strategy identified 1359 articles. After duplicates were excluded, a further screening based on the title and abstract to assess the relevance of the articles excluded 1314 of them. The remaining 29 articles were selected for full-text reading. This resulted in a total of 20 articles that met our inclusion criteria for this review.

Nineteen of the 20 research articles selected had a total number of subjects that ranged from 18 to 60 people, with the age of 40 years and above of both male and female gender. One article only studied female subjects and attributed knee osteoarthritis to the subjects' postmenopausal condition. Almost all articles had included both unilateral and bilateral involvement of the knee osteoarthritis along with four types of osteoarthritis determined by the Kellgren and Lawrence classification, with grade 1–3 being the most common that was found between the studies and only two studies involving up to grade 4.

The retro walking exercises given together with conventional therapy in the articles reviewed were carried out for 2–6 weeks, but one article only did it for 5 days. The intensity of retro walking given during one week varied from 3–15 times, with a total duration of 30–240 minutes. Almost all articles gave the duration of exercise in one retro walking session as 10 minutes, with 4 articles increasing the duration gradually over the span of the study to 15–30 minutes per session. Treadmills were utilized in six articles, two of which included handrails and one was an underwater treadmill. One study gave an incline of 10%. Patients were asked to walk at a pace they were comfortable with in eight articles, while the other four articles asked patients to walk at the maximum speed they could. One article gave a treadmill walking speed of 1.0km/h for week one and 1.5km/h for week two. To accompany the retro walking, six articles provided warm-up and cool-down exercises such as leisurely forward walking, slow forward and backward walking, and heel raises. One article did not provide information regarding the duration or details of the retro walking protocol.

The outcome measures in each article were aspects that support the improvement of functional ability. The functional ability of the subjects was measured in almost every article using the Western Ontario and McMaster Universities Osteoarthritis Index, while two other articles used the Self efficacy for Managing Chronic Disease measurement scale and the Ibadan Knee/Hip Osteoarthritis Measure. Another aspect measured was the pain scale using the Visual Analogue Scale and Numerical Pain Rating Scale, while one article used the Intermittent and Constant Osteoarthritis Pain measure. Knee joint range of motion was measured in five articles using a goniometer. Strength of upper limb muscles such as quadriceps, hip abductors, and hip extensors was measured in four articles using a dynamometer and Medical Research Council grading. The subjects' balance and mobility ability were measured with the Timed Up and Go test in six articles, and another article used a device called Pro-kin 254P from TecnoBody Company to check static balance and proprioception. Several gait parameters

were also measured such as walking speed by walking on a 10-meter path, cadence by counting the number of steps in 1 minute, stride and step length by measuring the distance between each footprint. One article measured kinesiophobia using the Tampa Scale for Kinesiophobia. Information regarding all the reviewed articles is presented in Table 1.

DISCUSSION

Retro walking has been reported to have many benefits for the lower extremity in various conditions. The benefits are not limited to aspects of balance, proprioception, and muscle strength and flexibility (Balasukumaran et al., 2019; Parikh & Desai, 2022, 2022; Tahreem et al., 2023). Many researchers have studied its effect on knee osteoarthritis patients. Twenty articles are included in this review, all of them found beneficial effects of retro walking for knee osteoarthritis patients in terms of functional ability and other aspects that support it such as reduced pain, increased balance and mobility, increased range of motion and strength.

Although retro walking has been shown to be safe for osteoarthritis patients, supervision and safety precautions are still needed, especially for patients with more severe conditions. The safety of retro walking is partly due to the minimal walking load received by the knee joint when performing retro walking on a medium in the form of a regular flat surface such as a floor or treadmill without using any additional loading, thus relieving patients from pain and exercising knee function, so far no one has also reported serious side effects during the study period (Frye, 2001; Li-Yuan Chen et al., 2000).

In this study almost all of the selected articles described the details of the retro walking exercise provided including the duration of each session and the total number of sessions during the study period, but none of the articles were specific about the speed of the retro walking, with the exception of one study that reported a treadmill speed of 1.0km/h in week one and 1.5km/h in week two. The duration of most retro walking sessions was 10 minutes, with some studies increasing the duration to 15–20 minutes at regular intervals, resulting in an average total training duration per week of 70.2 minutes. This is consistent with a pilot study which found that 70 minutes per week of moderate-intensity walking activity was safe for patients with grade 3–4 or severe knee osteoarthritis (Abolhasani et al., 2019; Wallis et al., 2015).

All research articles provide retro walking exercises accompanied by conventional therapy which can be in the form of exercises or other therapeutic modalities such as hot packs, but one other article did not mention the details of the conventional therapy provided, and one other study only added the use of ultrasound or transcutaneous electrical nerve stimulation without providing exercises other than retro walking (Somashekar et al., 2015).

The comparison intervention group mostly used conventional therapy in the form of lower extremity-focused exercises along with other therapeutic modalities such as hot packs, shortwave diathermy, transcutaneous electrical nerve stimulation, and ultrasound. Three studies combined these conventional therapies with forward walking as a comparison for the retro walking group, and one study used balance training. Each study included a conventional therapy program for the retro walking group as a supplement.

Table 1. Summary of the included articles

Study	Walking duration	Sample characteristics	Outcome measures
Sarkar et al., 2019 Saudi Arabia	10-30 min per session (gradually), total 30-90 min per week (3 sessions per week, for 6 weeks)	45 (Control = 22) Grade I to III Kellgren and Lawrence (knee involvement not specified)	WOMAC NPRS
AM Balraj, et al., 2018 India	10 min per session, total 240 min per week (12 sessions per week, for 3 weeks)	30 (Control = 15) Grade III to IV Kellgren and Lawrence Unilateral or bilateral involvement	WOMAC
Pratiwi et al., 2023 Indonesia	10 min per session, total 60 min per week (3 sessions per week, for 5 weeks)	26 (Control = 14) (Grade and knee involvement not specified)	WOMAC
Baby and Thachil, 2022 India	10 min per session, total 30 min per week (3 sessions per week, for 3 weeks)	18 (Control = 9) (Grade and knee involvement not specified)	WOMAC TUG Sphygmomanometer test
Gondhalekar and Deo, 2013 India	10 min per session, total 210 min per week (7 sessions per week for 3 weeks)	30 (Control = 15) (Grade not specified) Unilateral involvement	WOMAC VAS
Gurjalwar et al., 2022 India	7-15 (gradually) min per session, (7 sessions per week, for 4 weeks)	1 (Grade not specified) Unilateral involvement	WOMAC VAS
Rathi, Palekar and Varghese, 2014 India	10 min per session, total 30 min per week (3 sessions per week, for 2 weeks)	20 (Control = 10) Grade I to grade III Kellgren and Lawrence Unilateral or bilateral involvement	WOMAC NPRS
N Malik M and A Sudhan M, 2023 India	10 min per session, total 120 min per week (6 sessions per week, for 3 weeks)	30 (Control = 15) Grade II to III Kellgren and Lawrence Unilateral involvement	WOMAC VAS Dynamometer
	10 min per session (for 4 weeks)	30 (Control = 15) Grade III	WOMAC

Table 1. Summary of the included articles

Study	Walking duration	Sample characteristics	Outcome measures
Manisha, Joginder and Priyanka, 2015 India		Osteoarthritis WOMAC score between 45-90	
Gurudut et al., 2019 India	15 min per session, total 75 min per week (1 session per day, for 5 days)	28 (Control = 14) Grade II to III Kellgren and Lawrence (knee involvement not specified)	Popliteal angle measurement walking velocity cadence Tampa scale for kinesiophobia 11 Self-efficacy for Managing Chronic Disease: A 6-item scale
Rangey, Sheth and Vyas, 2016 India	10 min per session, total 120 min per week (6 sessions per week, for 2 weeks)	20 (Control = 10) (Grade not specified) Bilateral involvement	WOMAC Short Form Health Survey (SF36) VAS
Kogilavani. et al., 2023 India	20 min per session (gradually), total 80 min per week (4 sessions per week, for 6 weeks)	30 (Control = 15) Grade I to III Kellgren and Lawrence Unilateral or bilateral involvement	WOMAC NPRS
Naik, Rathod and Kumar, 2020 India	10 min per session, total 50 min per week (5 sessions per week, for 2 weeks)	30 (Control = 15) (Grade not specified) Unilateral or bilateral involvement	WOMAC TUG
Somashekar et al., 2015 India	10 min per session, total 150 min per week (15 sessions per week, for 3 weeks)	60 (Group B = 30) Grade II Kellgren and Lawrence (knee involvement not specified)	WOMAC VAS Goniometer
Joshi, Singh and Vij, 2019 India	10 min per session, total 30 min per week (3 sessions per week, for 3 weeks)	42 (Control = 21) Grade IV Osteoarthritis (knee involvement not specified)	WOMAC TUG VAS Foot print method (stride and step length)

Table 1. Summary of the included articles

Study	Walking duration	Sample characteristics	Outcome measures
Shabbir et al., 2022 Pakistan	30 (combined with conventional treatment) (3 sessions per week, for 6 weeks)	36 (Control = 18) Grade I to III Kellgren and Lawrence Bilateral involvement	WOMAC NPRS TUG
Ganu and Merchant, 2018 India	10 min per session (21 sessions per week, for 4 weeks)	40 (Control = 20) (Grade not specified) Unilateral involvement	WOMAC TUG NPRS Muscle strength goniometer
Krishnan and Pithadia, 2021 India	10 min per session, total 30 min per week (3 sessions per week, for 6 weeks)	40 (Control = 20) (Grade not specified) Unilateral involvement	ICOAP IKHOAM
Dewanti and Rahmawati, 2022 Indonesia	(3 sessions per week, for 4 weeks)	31	WOMAC
Chen et al., 2021 China	10-30 min per session (gradually), total 30-90 min per week (3 sessions per week, for 4 weeks)	32 (Control = 16) Grade I to IV Kellgren and Lawrence Unilateral or bilateral involvement	NPRS WOMAC

Legend: WOMAC, Western Ontario and McMaster Universities Arthritis Index; NPRS, Numerical Pain Rating Scale; TUG, Timed Up and Go test; VAS, Visual Analogue Scale; ICOAP, Intermittent and Constant Osteoarthritis Pain measure; IKHOAM, Ibadan Knee/Hip Osteoarthritis Measure.

While all included articles found the retro walking group, along with the conventional program, to be superior in terms of knee functional ability for osteoarthritis patients compared to any of the comparison intervention groups, there were some studies that found modest improvements between the retro walking group and the other intervention groups in terms of hamstring flexibility, self-assessment of self-efficacy, proprioception, pain, and quality of life (Chen et al., 2021; Gurudut et al., 2019).

Overall the selected articles found improvements in the retro walking group on knee function in osteoarthritis patients, although there were differences in aspects of retro walking such as the medium of exercise and total duration per week. Conventional therapy still accompanies the administration of retro walking because conventional programs help ensure that the new therapy being tried will fit in with pre-existing practices that have been proven to be effective in solving problems in the structural aspects of the body to help functional abilities. In addition, although retro walking has been shown to help in several areas such as leg muscle strength, balance, and walking patterns, a combination program of conventional therapy and retro walking is still needed for a patient to fully address the condition of knee osteoarthritis.

This scoping review only reviewed studies in English and Indonesian, which

is a limitation on its own. The keywords used in the database search process are also only in English, so there is a possibility that the keywords used are not sufficient to provide more complete search results. Gray literature was not included in this review despite efforts to create a comprehensive review. Despite the limitations, findings were positive that retro walking is appropriate to be added in rehabilitation program to help patients with knee osteoarthritis maintain their functional ability.

CONCLUSION

Existing literature shows that retro walking is a good option for adjunct program to the existing conventional physiotherapy to improve various aspects related to functional ability of patients with knee osteoarthritis of all grades or severity.

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REFERENCES

Abolhasani, M., Halabchi, F., Honarpishe, R., Cleland, J. A., & Hakakzadeh, A. (2019). Effects of kinesiotape on pain, range of motion, and functional status in patients with osteoarthritis: a randomized controlled trial. *Journal of Exercise Rehabilitation*, *15*(4), 603–609. https://doi.org/10.12965/jer.1938290.145

Afifatuzzahra, S., Perdana, S. S., & Azizah, A. N. (2023). A Systematic Review: Does Land based Exercise Improve the Quality of Life in Patient with Knee Osteoarthritis? *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*, *7*(4), 1139–1149. https://doi.org/10.33369/jk.v7i4.31824

Alghadir, A. H., Anwer, S., Sarkar, B., Paul, A. K., & Anwar, D. (2019). Effect of 6-week retro or forward walking program on pain, functional disability, quadriceps muscle strength, and performance in individuals with knee osteoarthritis: a randomized controlled trial (retro-walking trial). *BMC Musculoskeletal Disorders*, *20*(1), 159. https://doi.org/10.1186/s12891-019-2537-9

AM, B., R, K., & B, K. (2018). Impact of Retro-Walking on Pain and Disability Parameters among Chronic Osteoarthritis Knee Patients. *Journal of Physiotherapy & Physical Rehabilitation*, *03*(02). https://doi.org/10.4172/2573-0312.1000157

Baby, E., & Thachil, A. (2022). Effectiveness of Retro Walking in Women with Osteoarthritis of Knee. *International Journal of Health Sciences and Research*, *12*(3), 326–345. https://doi.org/10.52403/ijhsr.20220344

Balasukumaran, T., Gottlieb, U., & Springer, S. (2020). Muscle activation patterns during backward walking in people with chronic ankle instability. *BMC Musculoskeletal Disorders*, *21*(1), 489. https://doi.org/10.1186/s12891-020-03512-x

Balasukumaran, T., Olivier, B., & Ntsiea, M. V. (2019). The effectiveness of backward walking as a treatment for people with gait impairments: a systematic review and meta-analysis. *Clinical Rehabilitation*, *33*(2), 171–182. https://doi.org/10.1177/0269215518801430

Bhatia, D., Bejarano, T., & Novo, M. (2013). Current interventions in the management of knee osteoarthritis. *Journal of Pharmacy And Bioallied Sciences*, *5*(1), 30. https://doi.org/10.4103/0975-7406.106561

Chen, Z., Ye, X., Wang, Y., Shen, Z., Wu, J., Chen, W., Jiang, T., Wu, H., & Xu, X. (2021). The Efficacy of Backward Walking on Static Stability, Proprioception, Pain, and Physical Function of Patients with Knee Osteoarthritis: A Randomized Controlled Trial. *Evidence-Based Complementary and Alternative Medicine*, *2021*, 1–9. https://doi.org/10.1155/2021/5574966

Cui, A., Li, H., Wang, D., Zhong, J., Chen, Y., & Lu, H. (2020). Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. *EClinicalMedicine*, *29–30*, 100587. https://doi.org/10.1016/j.eclinm.2020.100587

Dewanti, W. R., & Rahmawati, N. A. (2022). The Effect Of Combination Of Retrowalking Exercise And Static Contraction In Increasing Activity Daily Living Functions In Knee Osteoarthritis Risk Tea Pickers. *Jurnal Keperawatan Dan Fisioterapi (JKF)*, *5*(1), 67–74. https://doi.org/10.35451/jkf.v5i1.1246

Frye, E. (2001). *An electromyographic analysis study of forward and backward walking*.

Ganu, S. S., & Merchant, A. J. (2018). Effect of retrowalking on pain, functional disability and functional mobility in patients with chronic knee osteoarthritis. *International Journal of Health Sciences and Research*, *8*(11), 109–115.

Gondhalekar, G., & Deo, M. (2013). Retrowalking as an adjunct to conventional treatment versus conventional treatment alone on pain and disability in patients with acute exacerbation of chronic knee osteoarthritis: A randomized clinical trial. *North American Journal of Medical Sciences*, *5*(2), 108. https://doi.org/10.4103/1947-2714.107527

Gurjalwar, I., Kalaskar, G., Phansopkar, P., Shah, P., Chitale, N., & Wadhokar, O. C. (2022). Impact of a retro walking on degenerative osteoarthritis of knee joint. *Journal of Medical Pharmaceutical and Allied Sciences*, *11*(2320), 255–258. https://doi.org/10.55522/jmpas.V11S1.1251

Gurudut, P., Patel, R., Mukkannavar, P., & Vira, P. (2019). Effect of retro-walking on treadmill on hamstring flexibility, gait, kinesiophobia, and psychometry in individuals with chronic knee osteoarthritis. *Indian Journal of Physical Therapy and Research*, *1*(2), 93. https://doi.org/10.4103/ijptr.ijptr_29_19

Hsu, H., & Siwiec, R. M. (2018). *Knee osteoarthritis*.

Joshi, S., Singh, S. K., & Vij, J. S. (2019). Effect of Retrowalking, a Non-Pharmacological Treatment on Pain, Disability, Balance and Gait in Knee Osteoarthritis: A Randomized Controlled Trial. *Indian Journal of Public Health Research & Development*, *10*(2), 214. https://doi.org/10.5958/0976-5506.2019.00288.2

Krishnan, V., & Pithadia, K. (2021). Effect of retro walking versus balance training on pain and disability in patients with osteoarthritis of the knee: a randomized controlled trial. *Bulletin of Faculty of Physical Therapy*,

26(1). https://doi.org/10.1186/s43161-021-00035-x

Lespasio, M. J., Piuzzi, N. S., Husni, M. E., Muschler, G. F., Guarino, A. J., & Mont, M. A. (2017). Knee osteoarthritis: a primer. *The Permanente Journal*, *21*.

Li-Yuan Chen, Fong-Chin Su, & Ping-Yen Chiang. (2000). Kinematic and EMG analysis of backward walking on treadmill. *Proceedings of the 22nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (Cat. No.00CH37143)*, *2*, 825–827. https://doi.org/10.1109/IEMBS.2000.897841

M, N. M., & M, A. S. (2023). Comparative study between effect of Retrowalking and self-selected pace forward walking on improving pain and function in people with osteoarthritis knee. *International Journal of Physical Education, Sports and Health*, *10*(1), 196–203. https://doi.org/10.22271/kheljournal.2023.v10.i1c.2773

Manisha, N., Joginder, Y., & Priyanka, R. (2015). Effect of Retro Walking on Pain, Balance and Functional Performance in Osteoarthritis of Knee. *Indian Journal of Physiotherapy and Occupational Therapy - An International Journal*, *9*(3), 154. https://doi.org/10.5958/0973-5674.2015.00115.X

Naik, R. P., Rathod, D., & Kumar, A. (2020). Effects of Retro-Walking Underwater Treadmill Training on Pain, Functional Performance & Functional Mobility in Patients With Knee Osteoarthritis. *International Journal of Physiotherapy and Research*, *8*(5), 3580–3585. https://doi.org/10.16965/ijpr.2020.154

Parikh, P. R., & Desai, D. S. (2022). Effectiveness of Forward Walking Versus Retro Walking on Balance, Gait Speed and Lower Body Functional Strength among the Elderly Population - A Comparative Study. *International Journal of Health Sciences and Research*, *12*(4), 283–291. https://doi.org/10.52403/ijhsr.20220433

Peters, M. D. J., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *International Journal of Evidence-Based Healthcare*, *13*(3), 141–146. https://doi.org/10.1097/XEB.0000000000000050

Pratiwi, A. N., Idris, I., Ariyandy, A., Mutmainnah, M., & Abdullah, A. R. A. H. (2023). *The Effect of Retrowalking Programme on Walking Pattern and Functional Ability in Knee Osteoarthritis Patients at Hasanuddin University Hospital*. https://doi.org/10.48047/ecb/2023.12.10.022

R., K., Velkumar, V., & E., S. (2023). Effectiveness of Retro Walking Exercise Versus Core Stability Exercise for Coastal Patients with Osteoarthritis of the Knee – A Randomized Active Control Study. *Journal of Coastal Life Medicine*, *11*(1 SE-Articles), 2452–2461. https://www.jclmm.com/index.php/journal/article/view/703

Rangey, P., Sheth, M., & Vyas, N. (2016). Comparison of effectiveness of forward and backward walking on pain, physical function, and quality of life in subjects with osteoarthritis of knee. *International Journal of Health & Allied Sciences*, *5*(4), 220. https://doi.org/10.4103/2278-

344X.194085

Rathi, M., Palekar, T., & Varghese, A. (2014). Efficacy of Backward walking on Patients with Osteoarthritis of Knee on Quadriceps Strength, Pain and Physical Functions. *Indian Journal of Physiotherapy and Occupational Therapy - An International Journal*, *8*(4), 192. https://doi.org/10.5958/0973-5674.2014.00036.7

Shabbir, S., Hashim, M., Sajjad, R., Kayani, M. S., Syed, F. A., Ibrahim, M., Hassan, D., & Ghouri, M. H. (2022). Effects of Retro-Walking on Pain, Functional Disability and Performance in Knee Osteoarthritis. *Pakistan Journal of Medical and Health Sciences*, *16*(2), 38–41. https://doi.org/10.53350/pjmhs2216238

Shu, Y., Gu, Y., Mei, Q., Ren, X., Popik, S., & Fernandez, J. (2016). Movement Analysis of Lower Limb During Backward Walking with Unstable Intervention. *Journal of Medical and Biological Engineering*, *36*(5), 718–725. https://doi.org/10.1007/s40846-016-0166-4

Somashekar, S., R, R., J N, S., Timsina, S., & Jha, V. (2015). A Study to Compare the Effectiveness of Transcutaneous Electrical Nerve Stimulation With Retro - Walking Versus Ultrasound Therapy With Retro - Walking in Chronic Osteoarthritis of Knee. *Journal of Evolution of Medical and Dental Sciences*, *4*(60), 10494–10503. https://doi.org/10.14260/jemds/2015/1512

Tahreem, R., Saima, R., Faraz, A., Shehzadi, I., Nimra, I., & Sidra, A. (2023). Effects of Retro Walking on Pain, Physical Function and Flexibility in Chronic Non-Specific Low Back Pain. *Iranian Rehabilitation Journal*, *21*(2), 13.

Wallis, J. A., Webster, K. E., Levinger, P., Singh, P. J., Fong, C., & Taylor, N. F. (2015). The maximum tolerated dose of walking for people with severe osteoarthritis of the knee: a phase I trial. *Osteoarthritis and Cartilage*, *23*(8), 1285–1293. https://doi.org/10.1016/j.joca.2015.04.001